ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

Routine Monitoring Program

Sources of Radiation

Members of the public are routinely exposed to various types (different sources) of ionizing radiation from both natural and man-made sources. The National Council on Radiation Protection and Measurements (NCRP) Report 93 (1987b) estimates that the average annual effective dose equivalent received by an individual living in the United States is about 360 millirem (mrem) (3.6 millisieverts [mSv]) from both natural and man-made sources of radiation.

While most of the radiation dose received by the general public is natural background radiation, man-made sources of radiation also contribute to the average dose. Such sources include diagnostic and therapeutic x-rays, nuclear medicine, fallout residues from atmospheric nuclear weapons tests, effluents from nuclear fuel-cycle facilities, and consumer products such as smoke detectors and cigarettes.

Routine activities at the West Valley Demonstration Project (WVDP or Project) can lead to the release of radioactive or hazardous substances that could affect the environment.

Exposure Pathways

The radionuclides present at the WVDP site are residues from the reprocessing of commercial nuclear fuel during the 1960s and early 1970s. A very small fraction of these radionuclides is released off-site during the year through ventilation systems and liquid discharges. These releases make a negligible contribution to the radiation dose to the surrounding population through several exposure pathways.

An exposure pathway consists of a way for a source of contamination or radiation to be transported by environmental media to a receptor where exposure to contaminants may occur. For example, a member of the public could be exposed to low concentrations of radioactive particulates carried by prevailing winds.

The potential pathways of exposure from Project emissions are inhalation of gases and particulates, ingestion of locally grown food products, ingestion of fish, beef, and deer tissues, and exposure to external penetrating radiation emitted from contaminated materials. The drinking water pathway is excluded from calculations of potential maximum dose to individuals because surveys revealed

Table 2-1
Potential Local Off-Site Exposure Pathways Under Existing WVDP Conditions

Exposure Pathway and Transporting Medium	Reason for Inclusion/Exclusion
Inhalation: gases and particulates in air (included)	Off-site transport of contaminants from WVDP stacks or resuspended particulates from soils or water
Ingestion: cultivated crops (included)	Local agricultural products irrigated with potentially contaminated surface or groundwater; foliar deposition and uptake of deposited airborne contaminants
Ingestion: surface and groundwater (excluded)	No documented use of local surface water or downgradient groundwater wells as drinking water by local residents
Ingestion: fish, beef, venison, and milk (included)	Fish exposed to contaminants in water or sediments may be consumed; beef, venison, and milk consumption following deposition of transported airborne and surface water contaminants
External exposure: radiation emanating from particulates and gases directly from air or surface water or indirectly from surface deposition (included)	Transport of air particulates and gases to off-site receptors; transport of contaminants in surface water and direct exposure during stream use and swimming

that local residents do not use Cattaraugus Creek as a source of drinking water. Table 2-1 (*above*) summarizes the potential exposure pathways for the local off-site population.

Land Use Survey

Periodic surveys of local residents provide information about local family sizes, sources of food, and gardening practices. In early 2003, census information from calendar year (CY) 2000 was used to update population files used for dose assessment. Information from the most recent land use survey, conducted in early 2002, was used to confirm the locations of the nearest residences. These parameters are required for computer models that are used for the annual dose assessments. (See the discussion of Dose Assessment Methodology [p. 2-29] for more information on the computer models used.)

Radiological Sampling Program Overview

The complete environmental monitoring schedule is delineated in Appendix B. This schedule provides information on monitoring and reporting requirements and the types and extent of sampling and monitoring at each location. An explanation of the codes that identify the sample medium and the specific sampling or monitoring location is also found in Appendix B (p. B-iii). For example, a sample location code such as AFGRVAL indicates an air sample (A), off-site (F), at the Great Valley (GRVAL) sampling station. These codes are used throughout this report for

ease of reference and to be consistent with the data reported in the appendices.

The food pathway is monitored by collecting samples of beef, hay, milk, and produce at near-site and remote locations, samples of fish upstream and downstream of the site, and venison samples from near-site deer and deer taken from background locations. Stream sediments are sampled upstream and downstream of the WVDP, and both on-site groundwater and off-site drinking water are routinely sampled. Direct radiation is monitored on-site, at the perimeter of the site, in communities near the site, and at background locations.

The primary focus of the monitoring program, however, is on surface water and air pathways, as these are the principal means of transport of radionuclides from the WVDP.

Liquid and air effluents are monitored on-site by collecting samples at locations where radioactivity or other regulated substances are released or might be released. Release points include water effluent outfalls and plant ventilation stacks.

Surface water samples are collected within the Project area from ponds, swamps, seeps, and drainage channels that flow through the Western New York Nuclear Service Center (WNYNSC) and then off-site into Cattaraugus Creek.

Both surface water and air samples are collected at site perimeter locations where the highest off-site concentrations of transported radionuclides might be expected. Samples are also collected at remote locations to provide background concentration data for comparison with data from on-site and near-site samples.

Surface Water Sampling Locations. Automatic samplers collect surface water at points along drainage channels within the WNYNSC that are most likely to show any radioactivity released from the site. These automatic samplers collect 50 milliliters (mL) of water (about one-quarter of a cup) every half-hour. The water is pumped into a large container where it is accumulated and mixed, and from which the composited sub-samples are then collected.

Collecting a Sample at a Stream Sampling Location

The samplers operate on-site at four locations: WNSP006, the point in Frank's Creek where Project drainage leaves the security-fenced area; WNNDADR, the drainage point downstream of the U.S. Nuclear Regulatory Commission (NRC)-licensed disposal area (NDA); WNSWAMP, the northeast swamp drainage; and WNSW74A, the north swamp drainage.

Off-site automatic samplers collect surface waters from Buttermilk Creek at a background sta-

tion upstream of the site (WFBCBKG), from Buttermilk Creek downstream of the site at Thomas Corners Road bridge (WFBCTCB, which is the last monitoring point before Buttermilk Creek leaves the WNYNSC), and from Cattaraugus Creek at Felton Bridge (WFFELBR). Grab samples are collected at several other surface water locations both on-site and off-site, including a background location on Cattaraugus Creek at Bigelow Bridge (WFBIGBR).

Figure A-2 (p. A-4 in Appendix A) shows the locations of the on-site surface water monitoring points. Figure A-3 (p. A-5) shows the locations of the off-site surface water monitoring points.

Air Sampling Locations. Air samplers are located on-site, at the perimeter of the site, and at points remote from the WVDP. Figure A-4 (p. A-6) shows the locations of the on-site air effluent monitors and samplers and the on-site ambient air samplers; Figures A-5, A-12, and A-13 (pp. A-7, A-14, and A-15) show the locations of the perimeter and remote air samplers.

Methods for monitoring and sampling air emission points and for sampling ambient air are described later in this chapter. (See Ventilation and Emission Systems [p. 2-15] and Perimeter and Remote Ambient Air Monitoring [p. 2-18].)

Overview of Water Effluent and Ambient Surface Water Monitoring

The WVDP site is drained by several small streams. (See Surface Water Hydrology of the West Valley Site in Chapter 4 [p. 4-2] and Figs. A-2 [p. A-4] and A-3 [p. A-5].) Frank's Creek flows along and receives drainage from the south plateau. As Frank's Creek flows northward, it is joined by a tributary, Erdman Brook, which receives effluent from the low-level waste treatment facility (LLWTF). On the north plateau, beyond the Project fence line, the north and northeast swamp areas and Quarry Creek drain into Frank's Creek.

Frank's Creek continues past the WVDP perimeter and flows across the WNYNSC, where it enters Buttermilk Creek. Radionuclide concentrations in Buttermilk Creek are monitored upstream and downstream of the WVDP. Further downstream, Buttermilk Creek leaves the WNYNSC and enters Cattaraugus Creek, which is also monitored for radionuclide concentrations both upstream and downstream of the point where the creek receives effluents from the WVDP.

Liquid effluents from three locations (one process release point from the LLWTF and two natural drainages from the northeast and north swamps) are primary contributors to site dose estimates. (See Predicted Dose From Waterborne Releases [p. 2-32] for an estimate of the dose attributable to these waterborne effluents.)

Low-Level Waste Treatment Facility Effluent. The discharge from the LLWTF through the lagoon 3 weir (WNSP001 on Fig. A-2 [p. A-4]) into Erdman Brook, a tributary of Frank's Creek, is the largest single source of radioactivity released to surface waters from the Project. There were seven batch releases totaling about 13.7 million gallons (52.0 million liters) in 2002. Composite samples were collected near the beginning and end of each discharge and one effluent grab sample was collected during each day of discharge. Samples were analyzed for gross alpha and gross beta radioactivity, for gamma-emitting radionuclides, and for specific radionuclides as noted in Appendix B (p. B-7).

The total amounts of radioactivity from specific radionuclides in the lagoon 3 effluent are listed in Appendix C, Table C-2A (p. C-13). The annual average concentration of each radionuclide is di-

Table 2-2
2002 Gross Alpha Concentrations at Surface Water Sampling Locations

Location	Number of Samples	Range		Annual Average	
		(µCi/mL)	*(Bq/L)*	*(µCi/mL)*	*(Bq/L)*
Off-Site					
WFBCBKG	12	<3.76E-10 to 1.48E-09	<1.39E-02 to 5.48E-02	5.76±7.34E-10	2.13±2.71E-02
WFBCTCB	12	<6.85E-10 to 1.59E-09	<2.53E-02 to 5.89E-02	5.25±8.19E-10	1.94±3.03E-02
WFBIGBR	12	<7.56E-10 to 1.62E-09	<2.80E-02 to 5.99E-02	7.03±9.68E-10	2.60±3.58E-02
WFFELBR	12	<9.11E-10 to 1.15E-08	<3.37E-02 to 4.26E-01	2.47±1.34E-09	9.15±4.95E-02
On-Site					
WNNDADR	12	<9.89E-10 to 2.60E-09	<3.66E-02 to 9.62E-02	0.73±1.36E-09	2.70±5.04E-02
WNSP006	52	<7.26E-10 to 3.02E-09	<2.69E-02 to 1.12E-01	0.69±1.44E-09	2.54±5.32E-02
WNSW74A	52	<1.09E-09 to 2.67E-09	<4.05E-02 to 9.86E-02	0.05±2.56E-09	0.19±9.48E-02
WNSWAMP	52	<1.12E-09 to 1.62E-09	<4.16E-02 to 6.01E-02	0.33±2.05E-09	1.23±7.60E-02

Table 2-3
2002 Gross Beta Concentrations at Surface Water Sampling Locations

Location	Number of Samples	Range		Annual Average	
		(µCi/mL)	*(Bq/L)*	*(µCi/mL)*	*(Bq/L)*
Off-Site					
WFBCBKG	12	<1.17E-09 to 3.64E-09	<4.32E-02 to 1.35E-01	2.38±1.19E-09	8.81±4.42E-02
WFBCTCB	12	4.62E-09 to 1.06E-08	1.71E-01 to 3.91E-01	8.14±1.53E-09	3.01±0.56E-01
WFBIGBR	12	9.89E-10 to 5.19E-09	3.66E-02 to 1.92E-01	2.67±1.21E-09	9.88±4.47E-02
WFFELBR	12	2.56E-09 to 9.14E-09	9.49E-02 to 3.38E-01	4.69±1.61E-09	1.74±0.60E-01
On-Site					
WNNDADR	12	1.41E-07 to 1.99E-07	5.22E+00 to 7.35E+00	1.73±0.07E-07	6.42±0.24E+00
WNSP006	52	1.72E-08 to 1.83E-07	6.36E-01 to 6.76E+00	4.52±0.37E-08	1.67±0.14E+00
WNSW74A	52	7.30E-09 to 1.85E-08	2.70E-01 to 6.85E-01	1.22±0.34E-08	4.50±1.27E-01
WNSWAMP	52	5.58E-07 to 6.99E-06	2.07E+01 to 2.59E+02	3.49±0.03E-06	1.29±0.01E+02

vided by its corresponding U.S. Department of Energy (DOE) derived concentration guide (DCG) in order to determine what percentage of the DCG was released. (DOE standards and DCGs for radionuclides of interest at the WVDP are found in Appendix K, Table K-1 [p. K-3].) As a DOE policy, the sum of the percentages calculated for all radionuclides released should not exceed 100%.

The combined annual average of radionuclide concentrations from the lagoon 3 effluent discharge weir in 2002 was approximately 34.4% of the DCGs. (See Table C-2B [p. C-14].) This is comparable to the average concentration over the last seven years of approximately 32%.

The low-level waste treatment facility was designed to efficiently remove strontium-90 and cesium-137, the more prevalent of the long-lived fission products in WVDP wastewaters. Other radionuclides are also removed to a lesser extent by the LLWTF. For example, one other major contributor to the total combined DCG in lagoon 3 effluent is uranium-232, which averaged about 9% of its DCG in 2002. Uranium-232 and other uranium isotopes are found in WVDP liquid waste because they were present in the nuclear fuel that was once reprocessed at the site. Variations in liquid effluent radionuclide ratios continue to reflect the dynamic nature of the waste streams being processed through the LLWTF.

(Outfall WNSP001, the lagoon 3 weir, is also monitored for nonradiological parameters under the New York State Pollutant Discharge Elimination System [SPDES] program. See Chapter 3, Environmental Nonradiological Program Information.)

Northeast Swamp and North Swamp Drainage. The northeast and north swamp drainages on the site's north plateau conduct surface water and emergent groundwater off-site.

The northeast swamp sampling location (WNSWAMP) monitors surface water drainage from the northeastern portion of the site's north plateau. The north swamp sampling point (WNSW74A) monitors drainage to Quarry Creek from the northern portion of the north plateau. (See Fig. A-2 [p. A-4].) Waters from the northeast swamp drainage run into Frank's Creek downstream of location WNSP006, the point in Frank's Creek where Project drainage leaves the security-fenced area. (See Other North Plateau Surface Waters and Water Effluent [p. 2-7].)

Samples from WNSWAMP and WNSW74A are collected weekly and analyzed for radiological parameters. Concentrations of all radioisotopic parameters detected at WNSWAMP and WNSW74A, other than strontium-90, were less than 1% of the respective DCGs for these parameters. The maximum and minimum gross alpha and gross beta indicator results from WNSWAMP and WNSW74A are noted on Tables 2-2 and 2-3 (p. 2-5). Data summaries from these two locations are found in Tables C-3C and C-3D (pp. C-30 and C-31 in Appendix C). Elevated gross beta concentrations at WNSWAMP, first noted in 1993, continued to be elevated through 2002. The average concentration in 2002 was lower than that measured in 2001. Gross beta activity at this location is largely attributable to strontium-90. (See Special Groundwater Monitoring [p. 4-16].)

Strontium-90 concentrations at WNSWAMP in 2002 averaged 1.77E-06 µCi/mL (65.5 Bq/L). (See Chapter 4, Fig. 4-4 [p. 4-18] for a graph of annualized average strontium-90 concentration at WNSWAMP in 2002.) Even though waters with elevated strontium-90 concentrations drain from WNSWAMP into Frank's Creek, waters collected from Cattaraugus Creek downstream at the first point of access by the general public (WFFELBR) were not significantly different from those at the background location, WFBIGBR, which is upstream of the location where

site drainage enters Cattaraugus Creek. (See Off-Site Surface Water [p. 2-10].)

Other North Plateau Surface Waters and Water Effluent. Samples taken from a point in Frank's Creek (WNSP006) and from the sanitary and industrial wastewater treatment facility discharge (WNSP007) are routinely monitored for radiological parameters. Discharges from WNSP001 and WNSP007 leave the site through point WNSP006. Radiological results of analyses from WNSP006 and WNSP007 are summarized in Table C-4C and (p. C-38) and Table C-2M (p. C-25). Samples from these points also are monitored for nonradiological parameters as part of the site's SPDES program. (See Chapter 3, Environmental Nonradiological Program Information.)

WNSP006. WNSP006 is located more than 2.5 miles (4.0 km) upstream from Thomas Corners Road, which is the last monitoring point before Buttermilk Creek leaves the WNYNSC and before the public has access to the creek waters. Samples from WNSP006 are retrieved weekly and composited both monthly and quarterly and are analyzed for the same radionuclides as the effluent samples from WNSP001.

The average gross alpha and gross beta data from location WNSP006 and the maximum and minimum results are noted in Tables 2-2 and 2-3 (p. 2-5) for comparison with sampling results from other on- and off-site surface water locations. As shown in Table 2-3, gross beta results for WNSP006 are generally higher than those at downstream and background locations. Figure 2-1 (*below*) shows the sixteen-year trends of gross alpha, gross beta, and tritium concentrations at location WNSP006. Fluctuations over this period reflect variable concentrations in treated WVDP liquid effluent being released from the site.

Many of the constituents detected at low levels in effluent from WNSP001 were not detectable downstream at location WNSP006. Except for strontium-90, all constituents that were detected were found at concentrations lower than 1% of

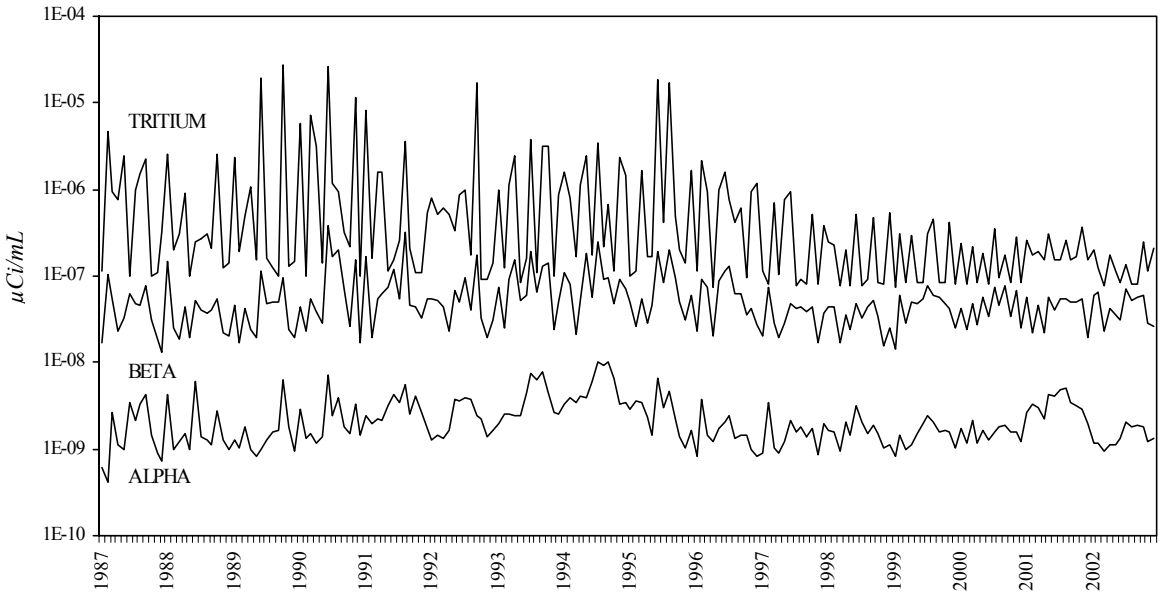


Figure 2-1. Sixteen-Year Trends of Gross Alpha, Gross Beta, and Tritium Concentrations at Sampling Location WNSP006

the respective DCG. The highest monthly concentration of strontium-90 at WNSP006 in 2002 was 3.31E-08 µCi/mL (1.22 Bq/L), which is less than 4% of its DCG (1E-06 µCi/mL).

Average concentrations in 2002 for the radiological parameters monitored at WNSP007 (gross alpha [as americium-241], gross beta [as strontium-90], tritium, and cesium-137) were also at small percentages of their respective DCGs.

Concentrations observed farther downstream at Felton Bridge (WFFELBR), the sampling location that represents the first point of public access to surface waters leaving the WVDP site, continue to be close to or indistinguishable from background.

WNSP005 and WNCOOLW. Sampling point WNSP005, which monitors overland drainage and groundwater seepage on the east side of the main plant, and WNCOOLW, which monitors coolant water from a contained basin within the facility, are sampled monthly for gross alpha, gross beta, and tritium concentrations. WNCOOLW also is sampled quarterly for gamma isotopes, including cesium-137. Summaries of radiological data for WNSP005 and WNCOOLW are found in Tables C-3A (p. C-29) and C-3H (p. C-33).

Average gross alpha and tritium concentrations for both locations were below detection levels in 2002. Average gross beta concentrations at WNSP005 and WNCOOLW were considerably lower than the strontium-90 DCG (<14% and <1%, respectively). Average cesium-137 concentrations at WNCOOLW were below detection levels in 2002. (Cesium-137 is not specifically measured at WNSP005.)

South Plateau Surface Water and NDA Interceptor Trench. Two inactive underground radioactive waste disposal areas, the NDA and the state-licensed disposal area (SDA), lie on the south plateau of the site. (The SDA is managed by the New York State Energy and Research Development Authority [NYSERDA].) The drum cell, an aboveground structure used to store approximately 19,000 drums of processed low-level radioactive waste (LLW), is located nearby. Surface waters, which flow from the south to the north, are routinely monitored at several points around these areas. (See Fig. A-2 [p. A-4].) In addition to the routine samples collected by the WVDP, samples are collected and analyzed by the New York State Department of Health (NYSDOH) at the two stream sampling points that receive drainage from the south plateau, WNFRC67 and WNERB53.

NRC-Licensed Disposal Area. Sampling point WNNDATR is a sump at the lowest point in the collection trench system constructed along the northeastern and northwestern sides of the NDA that intercepts groundwater from the NDA. Water collected underground at this location is pumped to the LLWTF for treatment prior to discharge at outfall WNSP001. (See p. 1-11 for an explanation of the NDA Interceptor Trench and Pretreatment System.) If radiological or nonradiological contamination were to migrate through the NDA, it would most likely be first detected in samples from WNNDATR. Monthly samples from WNNDATR are taken under the auspices of the environmental monitoring program and quarterly samples (sample point NDATR) under the auspices of the groundwater monitoring program. (See Chapter 3 [p. 3-3] and Chapter 4 [p. 4-15].)

Surface water drainage downstream of the NDA is monitored at WNNDADR. Further downstream, water from sampling point WNERB53 in Erdman Brook, which represents surface waters from the NDA before they join with drainage from the main plant and lagoon areas, also is monitored. Some drainage from western and northwestern portions of the SDA also passes through sampling points WNNDADR and WNERB53.

Annual concentrations from WNNDATR, the sump in the interceptor trench, are in Table C-3F (p. C-32) and quarterly results are listed under "NDATR" in Tables E-4, E-11, and E-13 (pp. E-12, E-16, and E-18, respectively). Results from WNNDADR, surface water drainage downstream of the NDA, are in Table C-3E (p. C-32), and results from WNERB53, the sampling location even further downstream of the NDA, are in Table C-4E (p. C-39). Parameters monitored at these three NDA sampling locations include gross alpha, gross beta, tritium, iodine-129, and cesium-137.

Gross alpha and gross beta results from WNNDADR are included in Tables 2-2 and 2-3 (p. 2-5) for comparison with results from other surface water locations. In addition, sixteen-year trends of gross alpha, gross beta, and tritium concentrations at WNNDADR are plotted in Figure 2-2 *(below)*. Allowing for seasonal variations, gross alpha and gross beta concentrations have been relatively stable over this time period, whereas tritium concentrations have been decreasing.

Gross Alpha. Gross alpha results from water samples taken at WNNDATR, WNNDADR, and WNERB53 in 2002 were indistinguishable from background results from Buttermilk Creek upstream of the site (WFBCBKG).

Gross Beta. Gross beta results at all three above locations were elevated with respect to background, but even the maximum concentration, at WNNDADR, was less than 20% of the DCG for strontium-90 in water (1E-06 µCi/mL). The maximum result at Erdman Brook (WNERB53), further downstream of the NDA, was less than 4% of the strontium-90 DCG. Gross beta activity at these locations is attributable largely to strontium-90. Residual soil contamination from past waste burial activities is thought to be the source of the activity. The NDA is thought to be the predominant source of gross beta activity observed at WNNDATR. Water collected at this location is treated prior to discharge at WNSP001.

Figure 2-2. Sixteen-Year Trends of Gross Alpha, Gross Beta, and Tritium Concentrations at Sampling Location WNNDADR

Tritium. Although tritium concentrations at WNNDATR and WNNDADR were also elevated with respect to background values (those from WNERB53 were not), the maximum concentrations from both WNNDATR and WNNDADR were less than 1% of the DCG for tritium in water (2E-03 µCi/mL). Allowing for seasonal variations, tritium concentrations seem to be generally decreasing at both WNNDATR and WNNDADR. Since the half-life of tritium is slightly longer than twelve years, decreasing tritium concentrations may be partially attributable to radioactive decay.

Iodine-129. A key indicator of possible migration of nonradiological organic contaminants from the NDA would be iodine-129, which is soluble in water and is known to travel with the organic contaminants present in the NDA. Iodine-129 concentrations at WNNDADR and WNNDATR in 2002 were statistically indistinguishable from background concentrations.

Cesium-137. No cesium-137 activity was detected at either WNNDATR or WNNDADR in 2002.

New York State-Licensed Disposal Area. Point WNSDADR is used to monitor drainage from trench covers on the southwestern area of the SDA. Immediately south of the SDA, and upstream of WNSDADR, sampling point WNDCELD is used to monitor surface drainage from the area around the drum cell. (See Fig. A-2 [p. A-4].) To the northeast, sampling point WNFRC67, in Frank's Creek, is used to monitor drainage downstream of the drum cell and the eastern and southern borders of the SDA. A summary of results from WNSDADR, WNDCELD, and WNFRC67 are in Tables C-3G (p. C-33), C-4G (p. C-40), and C-4F (p. C-40), respectively.

Tritium results at WNSDADR were elevated with respect to background measurements at WFBCBKG. Even so, the maximum result was less than 1% of the tritium DCG (2E-03 µCi/mL). All other radiological results in calendar year 2002 at sampling points WNSDADR, WNDCELD, and WNFRC67 were statistically indistinguishable from background.

Ponded (Standing) Waters. In addition to samples from moving water (streams or seeps), samples from ponds within the WNYNSC are also collected and tested annually for various radiological and water quality parameters to confirm that no major changes are occurring in standing water within the Project environs.

Four ponds near the site were tested in 2002. For comparison, a background pond 8.8 miles (14.1 km) north of the Project was also tested. (See Figs. A-2, A-3, and A-13 [pp. A-4, A-5, and A-15] for the locations of the five ponds and Table C-4H [p. C-41] for a summary of sampling results.) Although the gross beta results from standing water ponds WNSTAW4 and WNSTAW5 were elevated with respect to background, all other gross alpha, gross beta, and tritium results were statistically the same as concentrations in the background pond. If all gross beta activity at the two ponds were attributable to strontium-90, it would constitute less than 1% of the strontium-90 DCG (1E-06 µCi/mL).

Off-Site Surface Water. Samples of surface water are collected at four off-site locations, two on Buttermilk Creek and two on Cattaraugus Creek. Off-site surface water and sediment sampling locations are shown on Fig. A-3 (p. A-5). Tables 2-2 and 2-3 (p. 2-5) list the ranges and annual averages for gross alpha and gross beta activity at off-site surface water locations, which may be compared with data from on-site locations.

Fox Valley Road and Thomas Corners Bridge Sampling Locations. Buttermilk Creek is the major surface drainage from the WNYNSC. Two surface water monitoring stations are located on

Buttermilk Creek, one upstream of the WVDP at Fox Valley Road (WFBCBKG) and one downstream of the WVDP at Thomas Corners Bridge (WFBCTCB). The Thomas Corners Bridge sampling location is also upstream of Buttermilk Creek's confluence with Cattaraugus Creek. The Thomas Corners Bridge sampling location represents an important intercept point in the pathway to humans because dairy cattle have access to the water here.

Samples collected every week are composited monthly and analyzed for tritium, gross alpha, and gross beta radioactivity. A quarterly composite is analyzed for gamma-emitting radionuclides and strontium-90. Quarterly samples from WFBCBKG, the background location, also are analyzed for specific radionuclides as noted in Appendix B (p. B-31) and the results are used as bases for comparison with results of samples from site effluents.

Table C-4B (p. C-37) lists radionuclide concentrations at the Fox Valley Road background location compared with radionuclide concentrations downstream of the site at Thomas Corners Bridge.

Gross alpha, tritium, and cesium-137 concentrations at Thomas Corners Bridge were statistically the same as background concentrations in 2002. Gross beta and strontium-90 concentrations at Thomas Corners Bridge, however, were elevated in comparison to background and may be attributed to small amounts of radioactivity moving from the site, principally during periods of lagoon discharge via Frank's Creek.

The highest gross beta concentration at Thomas Corners Bridge was 1.06E-08 µCi/mL (0.39 Bq/L). If compared to the most conservative DOE guideline for beta emitters in water (strontium-90 at 1E-06 µCi/mL [37 Bq/L]), gross beta concentrations at Thomas Corners Bridge would be less than 2% of the DOE DCG. The highest strontium-90 concentration was 8.89E-09 µCi/mL (0.33 Bq/L), less than 1% of the DOE DCG.

Cattaraugus Creek at Felton Bridge and Bigelow Bridge Sampling Locations. Buttermilk Creek flows through the WNYNSC and then off-site, where it joins with Cattaraugus Creek. An automated sampler is located on Cattaraugus Creek at Felton Bridge (WFFELBR), just downstream of the point where Buttermilk Creek enters. Samples are collected weekly and analyzed for gross alpha, gross beta, and tritium concentrations. A chart recorder registers the stream depth during the sampling period so that a flow-weighted weekly sample can be proportioned into a monthly composite, which is analyzed for gross alpha, gross beta, tritium, strontium-90, and gamma-emitting radionuclides. (See Table C-4A [p. C-37].)

Background samples are collected monthly from Cattaraugus Creek at Bigelow Bridge (WFBIGBR), which is upstream of the point where Buttermilk Creek enters Cattaraugus Creek. These samples are analyzed for concentrations of gross alpha, gross beta, tritium, strontium-90, and gamma-emitting radionuclides. (See Table C-4A [p. C-37].)

No statistically significant differences were noted between results of analyses for gross alpha, tritium, strontium-90, and cesium-137 at either the upstream or downstream water sampling locations. However, gross beta concentrations at Felton Bridge (WFFELBR) were higher than those at both background locations. The highest gross beta concentration at Felton Bridge in 2002 was 9.14E-09 µCi/mL (0.34 Bq/L), which is about 1% of the DOE DCG for strontium-90. Figure 2-3 (p. 2-12) shows gross alpha, gross beta, and tritium results over the past sixteen years in Cattaraugus Creek samples taken at Felton Bridge. For the most part, tritium concentrations represent method detection limits and not detected radioactivity. (Method detection limit values are levels below which the analytical measurement could not detect any radioactivity. See Data Reporting in Chapter 1 [p. 1-4].) Taking into account seasonal fluctuations, gross beta activity appears to have remained relatively constant at this location since 1987.

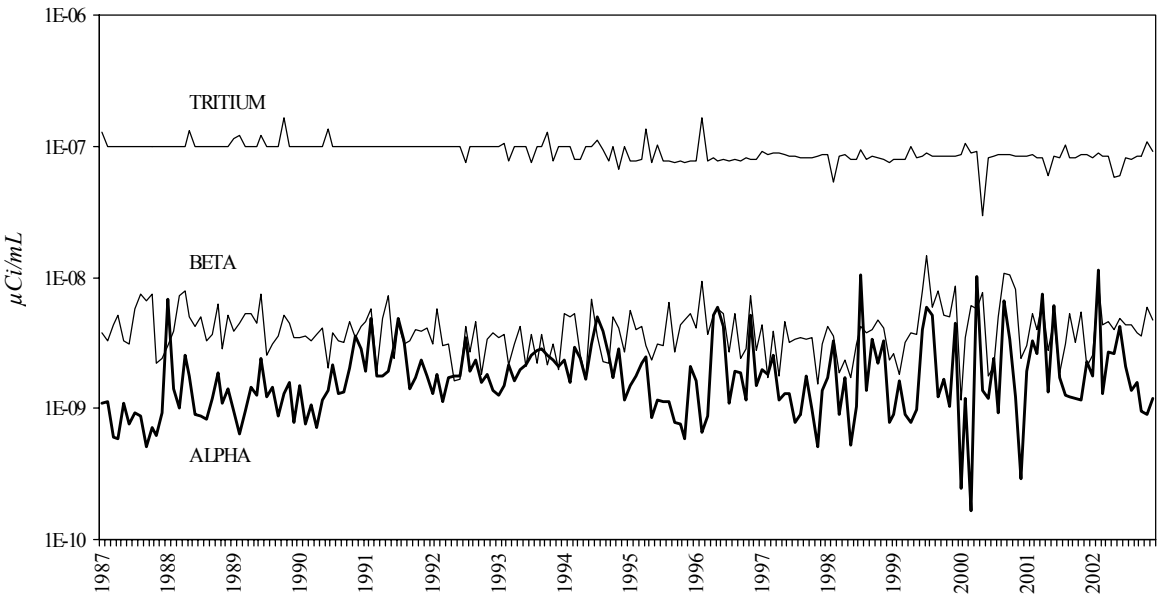


Figure 2-3. Sixteen-Year Trends of Gross Alpha, Gross Beta, and Tritium Concentrations at Sampling Location WFFELBR

Overview of Drinking Water Monitoring

Drinking water (potable water) is sampled both off-site (near the WVDP) and on-site. Off-site drinking water samples are taken from wells that represent the nearest unrestricted use of groundwater near the Project; none of these wells draw from groundwater units underlying the site. Drinking water and utility water for the Project are drawn from two on-site surface water reservoirs.

On-Site Tap Water. On-site drinking water sources were also monitored for radionuclides at four locations: the Environmental Laboratory (WNDNKEL), the maintenance shop (WNDNKMS), the main plant (WNDNKMP), and the utility room (WNDNKUR). Monthly samples were analyzed for gross alpha, gross beta, and tritium concentrations. Results of analyses of samples from site locations were compared with those from the entry point location at the utility room, which serves as a control comparison sampling location for these drinking water samples. No differences between control values and those from site locations were noted. (See Appendix C, Tables C-5B through C-5E [pp. C-46 and C-47].)

Off-Site Drinking Water Wells. Nine off-site private, residential wells between 0.9 miles (1.5 km) and 4.3 miles (7 km) from the facility were sampled for radiological parameters in 2002. A tenth private well, 18 miles (29 km) south of the site, provides a background sample. Sampling locations are shown in Figures A-9, A-12, and A-13 (pp. A-11, A-14, and A-15) in Appendix A. Results from the sampling are presented in Table C-5A (p. C-45). Radiological results in 2002 were statistically indistinguishable from background.

Overview of Aquatic Sediment Monitoring

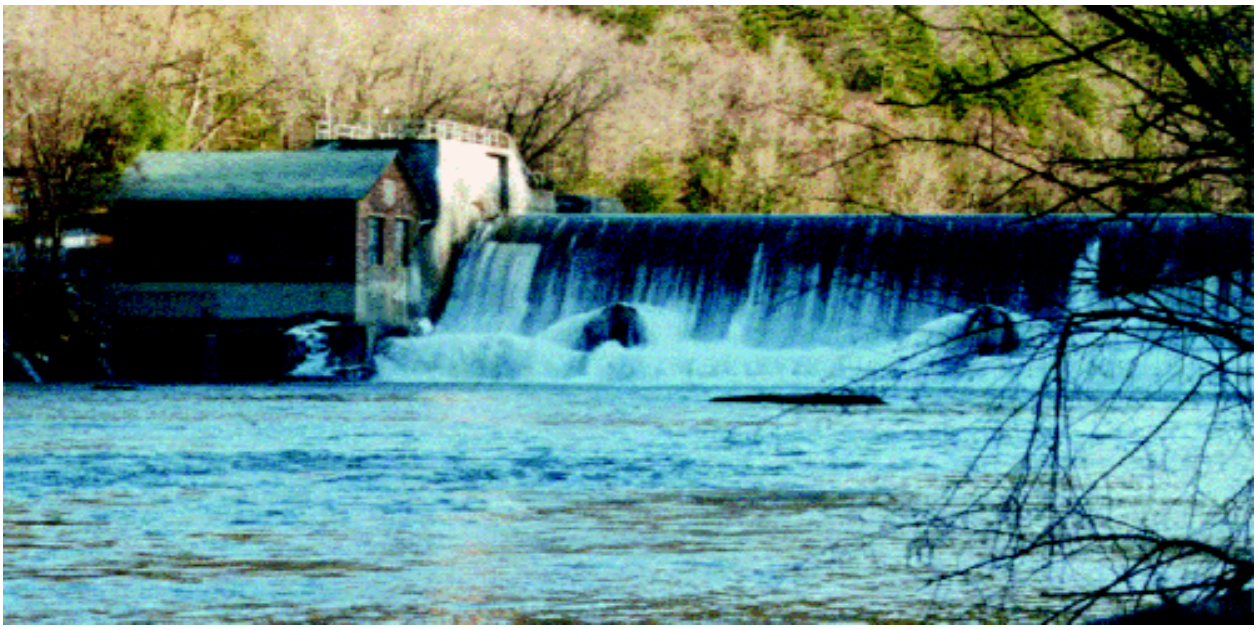
Particulate matter in streams can adsorb radiological constituents in liquid effluents, settle on the bottom of the stream as sediment, and subsequently be eroded or resuspended, especially during peri-

ods of high stream flow. These resuspended sediments may provide a pathway for radiological constituents to reach humans either directly via exposure or indirectly through the food pathway.

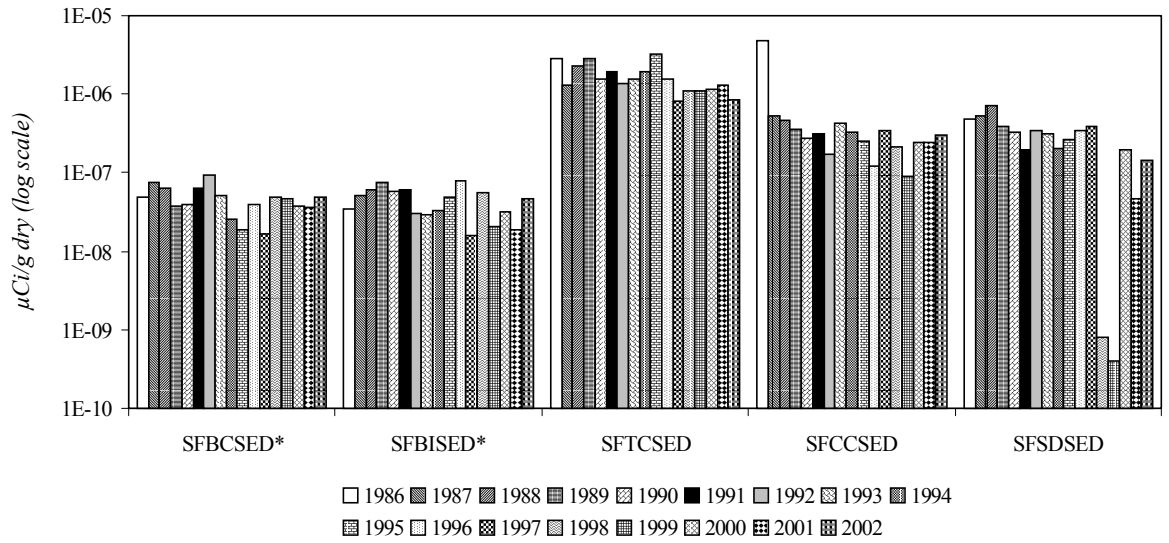
On-Site Aquatic Sediments. Sediment samples are taken from the same locations as surface water samples and are identified as on-site soil/sediment samples by the "SN" prefix. (See Appendix B [p. B-iii].) Soil or sediments are collected on-site at the three points where liquid effluents leaving the site are most likely to be radiologically contaminated: Frank's Creek where it leaves the security fence (SNSP006), the north swamp (SNSW74A) drainage swale, and the northeast swamp (SNSWAMP) drainage swale. Figure A-2 (p. A-4) shows the on-site sediment sampling locations. (Note that swamp sediment samples may be partially composed of soils.) Results from radiological analyses of these samples are listed in Tables G-2A through G-2C (pp. G-9 through G-11). As expected, gross beta, cesium-137, strontium-90, and certain alpha isotopic results higher than background were noted at the above three sediment sampling points.

Off-Site Aquatic Sediments. Sediments are collected off-site at three locations downstream of the WVDP: Buttermilk Creek at Thomas Corners Road (SFTCSED), Cattaraugus Creek at Felton Bridge (SFCCSED), and Cattaraugus Creek at the Springville dam (SFSDSED). The first two sampling points are located at automatic water samplers. The other is behind the Springville dam, where water would be expected to transport and deposit sediments that had adsorbed radionuclides from the site. Locations upstream of the WVDP are Buttermilk Creek at Fox Valley Road (SFBCSED) and Cattaraugus Creek at Bigelow Bridge (SFBISED). The two upstream locations provide background data for comparison with downstream points. Figure A-3 (p. A-5) shows the off-site sediment sampling locations.

Most radiological results from downstream sediment sampling sites were statistically the same as those from background locations. However, sediments from Buttermilk Creek near Thomas Corners, the sampling location immediately downstream of the site, contained cesium-137 concentrations



Springville Dam on Cattaraugus Creek



** Background (upstream) location*

Figure 2-4. Seventeen-Year Trends of Cesium-137 in Stream Sediments at Two Locations Upstream and Three Locations Downstream of the WVDP

statistically higher than background. Sediments from Cattaraugus Creek by Felton Bridge also contained elevated cesium-137 concentrations, consistent with historical results at this site. A comparison of annual averaged cesium-137 concentrations from 1986 through 2002 for the five off-site sampling locations is illustrated in Figure 2-4 (*above*). As the figure indicates, cesium-137 concentrations are relatively stable at the two background locations (SFBCSED and SFBISED) and are either stable or declining at the three locations downstream of the WVDP (SFTCSED, SFCCSED, and SFSDSED).

Although cesium-137 activity historically is elevated in downstream Cattaraugus Creek sediments relative to upstream sediments (Appendix G, Table G-2E [p. G-14]), the levels are far lower than those of naturally-occurring gamma emitters such as potassium-40. (See Fig. 2-5 [*at right*], which is a graphic comparison of cesium-137 to potassium-40 at the downstream location nearest the WVDP, Buttermilk Creek at Thomas Corners Road – SFTCSED.)

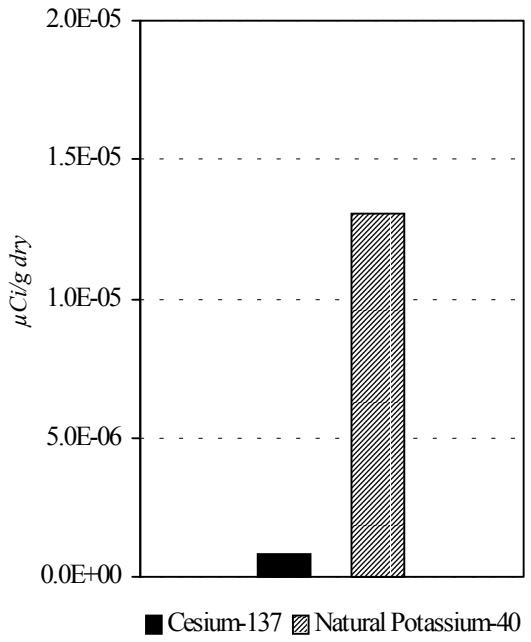


Figure 2-5. Comparison of Cesium-137 With Naturally-Occurring Potassium-40 Concentrations in 2002 at Downstream Sampling Location SFTCSED

Overview of Air Emission Standards and Guidelines

Permits obtained from the U.S. Environmental Protection Agency (EPA) allow air containing small amounts of radioactivity to be released from plant ventilation stacks during normal operations. The air released must meet criteria specified in the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations to ensure that the environment and the public's health and safety are protected. Dose-based comparisons of WVDP emissions against NESHAP criteria are presented later in this chapter. (See Radiological Effluents and Dose [p. 2-27].)

Unlike NESHAP dose criteria, the DOE DCGs are expressed in units of μCi/mL and therefore can be directly compared with concentrations of radionuclides in WVDP air emissions. DOE standards and DCGs for radionuclides of interest at the WVDP are found in Appendix K, Table K-1 (p. K-3).

Radiological parameters measured in air emissions include concentrations of gross alpha and gross beta, tritium, strontium-90, cesium-137, and other radionuclides. When isotopic data are not available, gross alpha and beta measurements are assumed to come from americium-241 and strontium-90, respectively, because the DCGs for these radionuclides are the most limiting for major particulate emissions at the WVDP.

Ventilation and Emission Systems. The exhaust from each EPA-permitted ventilation system on-site is continuously filtered and the permanent systems are monitored as air is released to the atmosphere. Because concentrations of radionuclides in air emissions are quite low, a large volume of air must be sampled at each point in order to measure the quantity of specific radionuclides released from the facility. Specially designed sampling nozzles continuously remove a representative portion of the exhaust air, which is then drawn through very fine glass fiber or membrane filters to trap particulates. Sensitive detectors continuously monitor these filters and provide readouts of alpha and beta radioactivity levels.

Separate sampling units on the ventilation stacks of the permitted systems contain another glass fiber filter that is removed every week and tested in the laboratory. These filters are analyzed routinely for the parameters delineated in Appendix B of this report.

Special samples also are collected in order to monitor gaseous (non-particulate) emissions of radioactivity. For example, six of the sampling systems contain an activated carbon cartridge that collects gaseous iodine-129, and at two locations water vapor is collected by trapping moisture in silica gel desiccant columns. The trapped water is distilled from the silica gel desiccant and analyzed for tritium. Figure A-4 (p. A-6) shows the locations of on-site air monitoring and sampling points.

The Main Plant Ventilation Stack. The main ventilation stack (ANSTACK) is the primary source of airborne releases at the WVDP. This stack, which vents to the atmosphere at a height of approximately 200 ft (more than 60 meters), releases ventilation exhaust from several facilities, including the liquid waste treatment system, the analytical laboratories, and off-gas from the vitrification system.

Samples from the main plant stack are collected weekly and analyzed for gross alpha, gross beta, and tritium concentrations. Weekly filters are composited quarterly and analyzed for strontium-90, gamma-emitting radionuclides, total uranium, uranium isotopes, plutonium isotopes, and americium-241. Charcoal cartridges, collected weekly, are composited quarterly and analyzed for iodine-129. In addition, filters from the main plant venti-

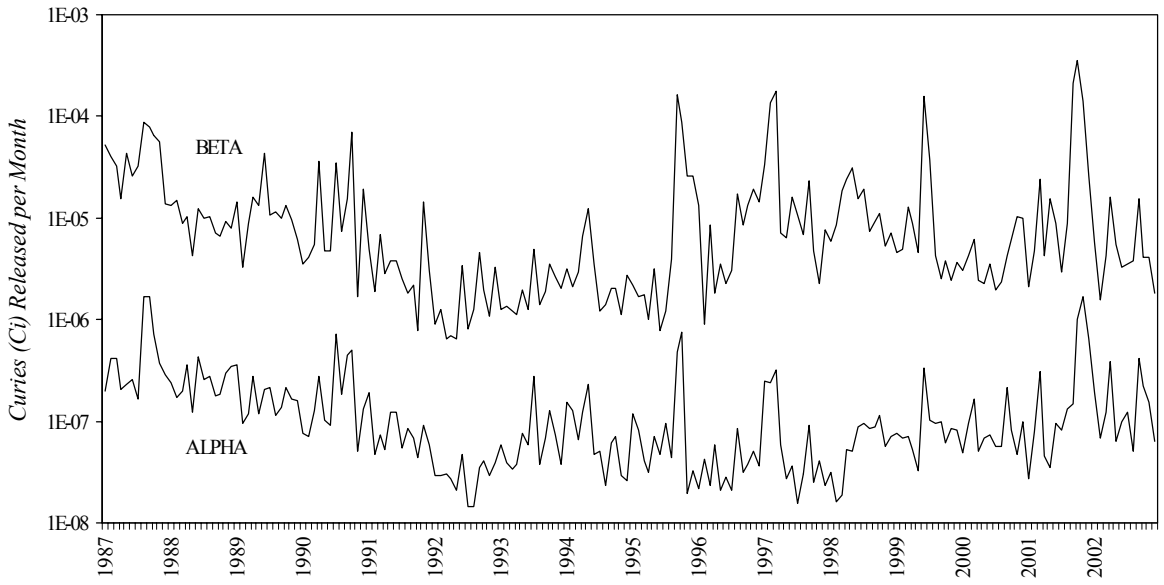


Figure 2-6. Sixteen-Year Trends of Gross Alpha and Gross Beta Activity at the Main Stack Sampling Location (ANSTACK)

lation stack sampler are routinely analyzed for strontium-89 and cesium-137 as part of operational-safety monitoring.

Monthly and quarterly total curies released from the main stack in 2002 are summarized in Table D-1 (p. D-3). Total curies released, annual averages, and a comparison of average isotopic concentrations with the applicable DCGs are summarized in Table D-2 (p. D-4). As in previous years, 2002 results show that average radioactivity levels at the point of discharge from the stack were already below concentration guidelines for airborne radioactivity in an unrestricted environment. Airborne concentrations from the stack to the site boundary are further reduced via dispersion by a factor of more than 200,000. Results from air samples taken just outside the site boundary confirm that WVDP operations had no discernible effect on off-site air quality. (See Perimeter and Remote Ambient Air Monitoring [p. 2-18].)

Figure 2-6 (*above*) shows the gross alpha and gross beta curies released per month from the main stack during the past sixteen years. The figure indicates a steady five-year downward trend in both gross alpha and gross beta activity from 1987 to mid-1992 and a stabilization through mid-1995. Previtrification transfers of cesium-loaded zeolite from waste tank 8D-1 to 8D-2 began in late 1995, and airborne releases increased.

In June 1998 the WVDP completed the first phase of high-level radioactive waste (HLW) vitrification, processing the bulk of the waste in tank 8D-2. In the latter part of 1998 the focus of the vitrification program shifted to the second phase, vitrifying the HLW residuals in the tank. Phase II vitrification continued through August 2002, when the last canister of HLW was poured. The melter was shut down in September 2002.

Since radioactive vitrification operations began in mid-1996, the radionuclide concentrations in air emissions have fluctuated while generally remain-

ing higher than concentrations before vitrification began. In general, average concentrations of gross beta, tritium, iodine-129, and cesium-137 decreased during the second phase of vitrification. Gross alpha, strontium-90, and alpha isotopic concentrations, however, increased slightly during the second phase. This phenomenon is thought to be partially attributable to the changing character of the waste being vitrified (residuals in phase II versus the bulk wastes of phase I). The changing radionuclide distribution may also reflect the increasing contribution to air emissions from decontamination of waste tanks, transfer lines, and main plant cells.

Vitrification Heating, Ventilation, and Air Conditioning (HVAC) Sampling System. Sampling point ANVITSK and the seismically protected backup sample point ANSEISK monitor emissions from the vitrification HVAC system. (Off-gas ventilation from the vitrification system itself is released through the main plant stack.)

Radioactivity concentrations were monitored at ANVITSK and ANSEISK before actual radioactive vitrification began in July 1996. The previtrification levels provide a baseline for comparison with concentrations of radionuclides in emissions during vitrification. Results from 2002 are found in Tables D-3 and D-4 (pp. D-5 and D-6). Concentrations of radionuclides measured during 2002 were indistinguishable from background values.

Other On-Site Air Sampling Systems. Sampling systems similar to those of the main stack monitor airborne effluents from the 01-14 building ventilation stack (ANCSSTK), the contact size-reduction facility ventilation stack (ANCSRFK), the supernatant treatment system ventilation stack (ANSTSTK), and the container sorting and packaging facility ventilation stack (ANCSPFK). (See Fig. A-4 [p. A-6].)

Tables D-5 through D-8 (pp. D-7 through D-10) show monthly totals of gross alpha and beta radioactivity and quarterly total radioactivity released for specific radionuclides at each of these sampling locations. Samples from these locations (ANCSSTK, ANSTSTK, and ANCSPFK) occasionally showed detectable concentrations of gross radioactivity as well as specific beta- and alpha-emitting radionuclides, but none approached any DOE effluent limitations. (ANCSRFK did not operate in 2002, therefore no samples were taken.)

Two other operations were routinely monitored for airborne radioactive releases in 2002: the LLWTF ventilation system (ANLLW2V), which came online in 1998, and the contaminated clothing laundry ventilation system (ANLAUNV). Sampling at ANLAUNV was discontinued in August 2002.

The low-level waste treatment facility ventilation point and the laundry ventilation system were sampled for gross alpha and gross beta radioactivity. These emission points are not required to be permitted because the potential magnitude of the emissions is so low. Although only semiannual grab sampling was required in 2002 to verify the low level of emissions, both points were sampled continuously while discharging to the environment. Data for these facilities are presented in Tables D-9 through D-11 (pp. D-11 and D-12). Average results from both locations were below detection levels.

Permitted portable outdoor ventilation enclosures (OVEs) are used occasionally to provide the ventilation necessary for the safety of personnel working with radioactive materials in areas outside permanently ventilated facilities or in areas where permanent ventilation needs to be augmented. Air samples from OVEs are collected continuously while those emission points are discharging, and data from these portable ventilation units are included in annual airborne emission evaluations. (See Table D-15 [p. D-16].) Average discharges

from OVEs were well below DOE guidelines for alpha and beta radioactivity in an unrestricted environment.

Three on-site air samplers collect samples of ambient air in the vicinity of three on-site waste storage units – the lag storage area (ANLAGAM), the NDA (ANNDAAM), and the SDA (ANSDAT9). (See Fig. A-4 [p. A-6].) These samplers were put in place to monitor potential diffuse releases of radioactivity. Monitoring data from these locations are presented in Appendix D, Tables D-12 through D-14 (pp. D-13 through D-15).

With the exception of tritium results at ANSDAT9, radiological data sets for the three locations are statistically indistinguishable from results for background air monitoring locations at Great Valley (AFGRVAL) and Nashville (AFNASHV). Although tritium results at ANSDAT9 were elevated with respect to background, even the highest result (3.07E-12 µCi/mL [1.14E-04 Bq/L]) was less than 0.1% of the DOE DCG for tritium in air (1E-07 µCi/mL).

Perimeter and Remote Ambient Air Monitoring. Samples for radionuclides in air are collected continuously at six locations around the perimeter of the site and at four remote locations. Maps of perimeter and remote air sampling locations are found on Figures A-5, A-12, and A-13 (pp. A-7, A-14, and A-15).

The perimeter locations on Fox Valley Road (AFFXVRD), Rock Springs Road (AFRSPRD), Route 240 (AFRT240), Thomas Corners Road (AFTCORD), Dutch Hill Road (AFBOEHN), and at the site's bulk storage warehouse (AFBLKST) were chosen because they provide historical continuity (as former Nuclear Fuel Services, Inc. [NFS] sampling locations) or because they represent the most likely locations for detecting off-site airborne concentrations of radioactivity.

The remote locations provide data from nearby communities – West Valley (AFWEVAL) and Springville (AFSPRVL) – and from more distant background areas. Concentrations measured at Great Valley (AFGRVAL, 19 miles [30.9 km] south of the site) and Nashville (AFNASHV, 25 miles [39.8 km] west of the site in the town of Hanover) are considered representative of regional background air.

At all locations airborne particulates are collected on filters for radiological analysis. Samplers maintain an average flow of approximately 1.4 ft^3/min (40 L/min) through a 47-millimeter-diameter glass fiber filter. The sampler heads are set above the ground at the height of the average human breathing zone. Filters are collected weekly and analyzed after a seven-day "decay" period to remove interference from short-lived naturally-occurring

Changing an Air Filter at an Air Sampling Station

Table 2-4
2002 Gross Alpha Concentrations at Off-Site, Perimeter, and On-Site Ambient Air Sampling Locations

Location	Number of Samples	Range		Annual Average	
		(µCi/mL)	*(Bq/m³)*	*(µCi/mL)*	*(Bq/m³)*
AFBLKST	52	<5.04E-16 to 3.33E-15	<1.86E-05 to 1.23E-04	0.73±1.18E-15	2.71±4.38E-05
AFBOEHN	52	<7.15E-16 to 5.51E-15	<2.64E-05 to 2.04E-04	0.86±1.30E-15	3.19±4.80E-05
AFFXVRD	52	<7.78E-16 to 4.10E-15	<2.88E-05 to 1.52E-04	0.79±1.21E-15	2.93±4.50E-05
AFGRVAL	52	<7.04E-16 to 2.92E-15	<2.60E-05 to 1.08E-04	0.95±2.00E-15	3.52±7.38E-05
AFNASHV	52	<7.56E-16 to 3.02E-15	<2.80E-05 to 1.12E-04	0.36±3.86E-15	0.13±1.43E-04
AFRSPRD	52	<7.71E-16 to 5.28E-15	<2.85E-05 to 1.95E-04	0.73±1.19E-15	2.71±4.39E-05
AFRT240	52	<8.32E-16 to 3.80E-15	<3.08E-05 to 1.41E-04	0.71±1.21E-15	2.64±4.48E-05
AFSPRVL	52	<7.59E-16 to 3.49E-15	<2.81E-05 to 1.29E-04	0.86±1.27E-15	3.20±4.71E-05
AFTCORD	52	<6.83E-16 to 3.19E-15	<2.53E-05 to 1.18E-04	0.75±1.23E-15	2.78±4.56E-05
AFWEVAL	52	<8.98E-16 to 3.02E-15	<3.32E-05 to 1.12E-04	0.68±1.18E-15	2.53±4.37E-05
ANLAGAM	52	<6.14E-16 to 2.76E-15	<2.27E-05 to 1.02E-04	8.20±9.12E-16	3.03±3.37E-05
ANNDAAM	52	<5.17E-16 to 2.19E-15	<1.91E-05 to 8.10E-05	9.32±9.27E-16	3.45±3.43E-05
ANSDAT9	52	<8.10E-16 to 3.77E-15	<3.00E-05 to 1.40E-04	0.64±1.24E-15	2.35±4.59E-05

Table 2-5
2002 Gross Beta Concentrations at Off-Site, Perimeter, and On-Site Ambient Air Sampling Locations

Location	Number of Samples	Range		Annual Average	
		(µCi/mL)	*(Bq/m³)*	*(µCi/mL)*	*(Bq/m³)*
AFBLKST	52	1.02E-14 to 3.05E-14	3.76E-04 to 1.13E-03	1.91±0.33E-14	7.07±1.23E-04
AFBOEHN	52	9.65E-15 to 3.81E-14	3.57E-04 to 1.41E-03	1.95±0.35E-14	7.21±1.30E-04
AFFXVRD	52	8.94E-15 to 3.73E-14	3.31E-04 to 1.38E-03	1.96±0.34E-14	7.26±1.26E-04
AFGRVAL	52	9.60E-15 to 4.08E-14	3.55E-04 to 1.51E-03	1.92±0.51E-14	7.10±1.88E-04
AFNASHV	52	7.27E-15 to 7.03E-14	2.69E-04 to 2.60E-03	2.08±0.93E-14	7.68±3.44E-04
AFRSPRD	52	8.44E-15 to 3.22E-14	3.12E-04 to 1.19E-03	1.83±0.33E-14	6.76±1.22E-04
AFRT240	52	9.03E-15 to 3.24E-14	3.34E-04 to 1.20E-03	1.81±0.33E-14	6.71±1.23E-04
AFSPRVL	52	8.28E-15 to 3.30E-14	3.06E-04 to 1.22E-03	1.93±0.35E-14	7.14±1.28E-04
AFTCORD	52	7.97E-15 to 3.14E-14	2.95E-04 to 1.16E-03	1.91±0.34E-14	7.06±1.27E-04
AFWEVAL	52	1.01E-14 to 3.02E-14	3.74E-04 to 1.12E-03	1.91±0.33E-14	7.06±1.24E-04
ANLAGAM	52	6.97E-15 to 3.57E-14	2.58E-04 to 1.32E-03	2.04±0.27E-14	7.57±1.01E-04
ANNDAAM	52	<1.62E-15 to 3.28E-14	<6.00E-05 to 1.21E-03	1.90±0.26E-14	7.03±0.97E-04
ANSDAT9	52	7.94E-15 to 3.10E-14	2.94E-04 to 1.15E-03	1.89±0.35E-14	6.98±1.30E-04

radionuclides. After weekly sample filters are measured for gross alpha and gross beta concentrations, they are combined in a quarterly composite consisting of thirteen weekly filters. The composite is analyzed for specific alpha-emitting, beta-emitting, and gamma-emitting radionuclides.

At two locations, the nearest perimeter location in the direction of highest potential airborne deposition rate (Rock Springs Road) and the primary background location (Great Valley), desiccant columns are used to collect airborne moisture for tritium analysis and charcoal cartridges are used to collect samples for iodine-129 analysis.

Trends of gross alpha and gross beta concentrations at the Rock Springs Road location are shown in Figure 2-7 (*below*). Within a range of seasonal and weekly fluctuations, the concentrations have been relatively constant over the past sixteen years. The gross alpha and gross beta ranges and annual averages for each of the off-site sampling points are noted on Tables 2-4 and 2-5 (p. 2-19). All gross alpha averages were below detection levels. Gross beta results from samples taken at two near-site communities and from the site perimeter were statistically the same as those from the background samplers, suggesting that there is no adverse site influence on the air quality at these near-site locations. Gross beta concentrations at all off-site and perimeter locations averaged about 1.92E-14 µCi/mL, which is about 0.2% of the DCG for strontium-90 in air (9E-12 µCi/mL). The highest average gross beta concentration (2.08E-14 µCi/mL [about 0.23% of the DCG]) was at the Nashville background location.

Additional radionuclide data from these samplers are provided in Tables D-16 through D-25 (pp. D-17 through D-23).

Although low levels of tritium, strontium-90, iodine-129, and cesium-137 were detected in emissions from the main stack on-site, results for these radionuclides at near-site locations were indistinguishable from background values, confirming that

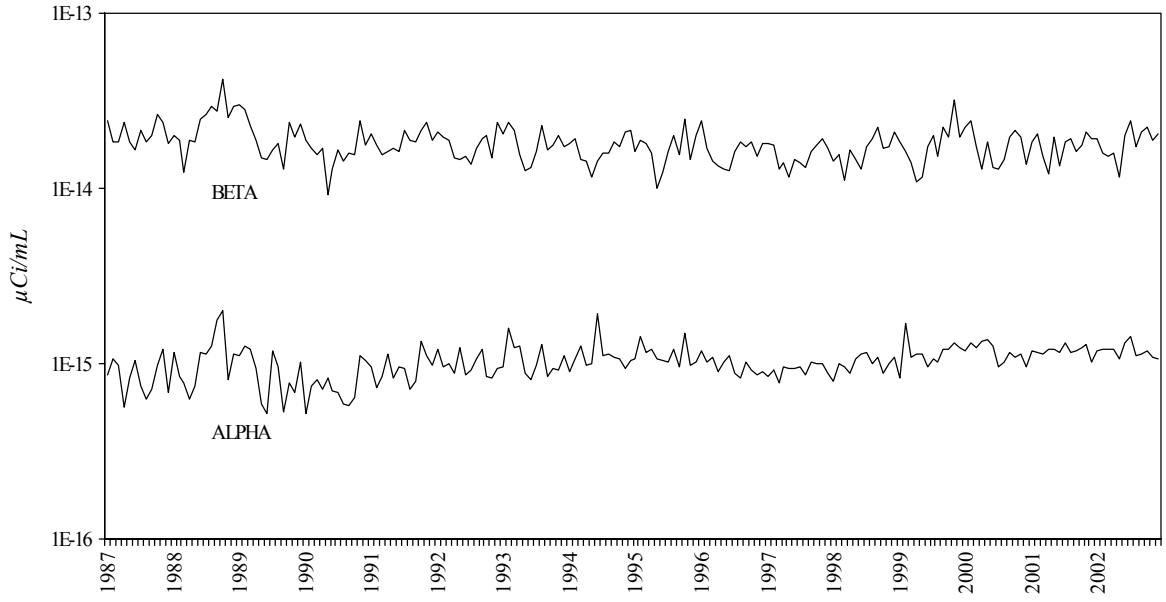


Figure 2-7. Sixteen-Year Trends of Gross Alpha and Gross Beta Concentrations at the Rock Springs Road Sampling Location (AFRSPRD)

site releases have a negligible effect on near-site air quality.

Atmospheric Deposition and Soil Monitoring

On-Site Fallout Pots. Short-term fallout samples are analyzed for radionuclide concentrations each month at four of the perimeter air sampler locations and at one on-site location near the rain gauge outside the Environmental Laboratory. (See Figs. A-4 and A-5 [pp. A-6 and A-7].) Monthly gross alpha, gross beta, potassium-40, and cesium-137 results are reported in nanocuries per square meter (nCi/m^2) and tritium results are reported in µCi/mL. The low levels of tritium and cesium-137 released in main stack emissions did not measurably affect on-site or perimeter fallout pot samples in 2002. The data from these analyses and the pH in precipitation are summarized in Tables D-26 through D-30 (pp. D-24 through D-26).

Off-Site Surface Soil. In order to assess long-term fallout deposition, surface soil near the off-site air samplers is collected annually and analyzed for radioactivity. Samples were collected from ten locations: six near-site points on the perimeter of the WNYNSC, two in nearby communities, and two in locations 19 to 25 miles (30 to 40 km) distant from the Project. Maps of the off-site surface soil sampling locations are on Figures A-3, A-12, and A-13 (pp. A-5, A-14, and A-15).

Concentrations of gross alpha and beta radioactivity, strontium-90, cesium-137, plutonium-239/240, and americium-241 were determined at all ten locations; concentrations of uranium isotopes and total uranium were determined at two perimeter locations and one background location. The measured concentrations of most site-related radionuclides in soils from the perimeter and community locations (Table G-2D [pp. G-12 and G-13]) were statistically indistinguishable from normal regional background concentrations. Elevated gross beta concentrations were noted at Thomas Corners, consistent with historical data from this soil sampling location. In 2002, as in the past, cesium-137 concentrations in surface soil from the Rock Springs Road location – northwest of the site – remained higher than background concentrations.

Overview of Food Chain Monitoring

Each year food and forage samples are collected from locations near the site (Fig. A-9 [p. A-11]) and from remote locations (Figs. A-12 and A-13 [pp. A-14 and A-15] in Appendix A). Fish and deer are collected during periods when they would normally be taken by sportsmen for consumption. Most milk samples are collected monthly; beef is collected semiannually. Hay, corn, apples, and beans are collected annually at the time of harvest.

Fish. Fish are obtained under a collector's permit by electrofishing, a method that temporarily stuns the fish, allowing them to be netted for collection. Electrofishing allows more efficient species-selective control than sport fishing, with unwanted fish being returned to the creek essentially unharmed.

Fish are collected from three locations in Cattaraugus Creek: Two locations are downstream of WNYNSC drainage – one above the Springville dam (BFFCATC) and one below the Springville dam (BFFCATD) – and one location is upstream of the site (BFFCTRL). (See Figs. A-9 and A-13 [pp. A-11 and A-15].)

A total of fifty fish were collected from Cattaraugus Creek in 2002 for testing. Twenty were taken from the control location upstream of the site (BFFCTRL), ten the first half of the year and ten the second half of the year. Twenty were taken immediately downstream of the site (BFFCATC) but above the Springville dam, ten

the first half of the year and ten the second half of the year. The remaining ten fish were taken below the dam (BFFCATD), including species that migrate about 40 miles (more than 60 km) upstream from Lake Erie.

The edible portion of each fish was analyzed for strontium-90 content and the gamma-emitting radionuclide cesium-137. (See Table F-4 [pp. F-6 through F-8] in Appendix F for a summary of the results.)

Strontium-90 results from fish above the Springville dam (at BFFCATC) were elevated in comparison with the background samples (from BFFCTRL), however, results from below the dam (BFFCATD) were not. Strontium-90 concentrations at both locations were within the range of historical results.

Cesium-137 concentrations were higher than background concentrations at downstream sampling location BFFCATD. Again, results were within the range of those noted in previous years.

Venison. Venison from vehicle-deer accidents around the WNYNSC and from deer collected far from the site (in the towns of Friendship, Angelica, and Cold Spring, New York) was analyzed for tritium, naturally-occurring potassium-40, strontium-90, and cesium-137 concentrations. (See Figs. A-9 and A-13 [pp. A-11 and A-15, respectively].) Results from these samples are shown in Table F-2 (p. F-4) in Appendix F.

Data from 2002 (as well as for the last eleven years) show no statistical differences between concentrations of these radionuclides in near-site and control samples.

From 1994 through 2000, during the big-game hunting season, hunters were allowed access to designated areas within the WNYNSC, excluding the WVDP premises, in a controlled hunting program established by NYSERDA. The hunt was canceled in 2001 because of heightened security concerns; hunting was resumed in 2002. Data from previous hunts have shown that concentrations of radioactivity in deer flesh have been very low, in-

Fish Collection in Cattaraugus Creek

dicating that Project activities have little or no effect on the local herd.

Beef. Beef samples are taken semiannually from both near-site and remote locations (Figs. A-9, A-12, and A-13 [pp. A-11, A-14, and A-15, respectively] in Appendix A) and are analyzed for tritium, potassium-40, strontium-90, and cesium-137. Results are presented in Table F-2 (p. F-4) in Appendix F. As with the deer samples, no significant differences were found between results for these radionuclides from near-site and background samples.

Milk. Monthly milk samples were taken from a dairy farm near the site to the north-northwest (BFMREED) – downwind in the prevailing wind direction from the WVDP – and from farms more than 15 miles (25 km) from the site and used as control locations (BFMCTLS and BFMCTLN). Annual milk samples were collected at two near-site farms to the south and east of the site (BFMSCHT and BFMWIDR). The locations of the near-site and remote sampling points are shown in Figs. A-9 and A-13 (pp. A-11 and A-15, respectively) in Appendix A.

The monthly samples from each location were composited into single quarterly samples for analysis. These quarterly composites and annual samples were analyzed for tritium, potassium-40, strontium-90, iodine-129, and cesium-137. Results are presented in Table F-1 (p. F-3) in Appendix F. Near-site sample results were indistinguishable from background control sample results.

Vegetables, Fruit, and Forage. Sweet corn, beans, apples, and hay were collected at near-site and background locations at harvest time. Sampling locations are shown on Figs A-9, A-12, and A-13 (pp. A-11, A-14, and A-15, respectively) in Appendix A. Samples were analyzed for tritium, potassium-40, cobalt-60, strontium-90, and cesium-137. Results are presented in Table F-3 (p. F-5) in Appendix F. Hay results are not directly incorporated into dose assessments, but are used as an indicator of potential uptake. (See Beef [p. 2-36] and Milk [p. 2-36].)

As has been observed in previous years, low levels of strontium-90 were noted in both background and near-site samples for all sample types. Strontium-90 concentrations in near-site vegetables and fruits were slightly elevated with respect to 2002 background, but results were not unusual as compared with historical results. Other radionuclide results were statistically the same as measurements from background samples.

Direct Environmental Radiation Monitoring

The year 2002 marked the nineteenth full year that environmental direct penetrating radiation was continuously monitored by the WVDP. Thermoluminescent dosimeters (TLDs) are placed at each monitoring location and changed out quarterly (every three months) for processing to obtain the integrated gamma radiation exposure at that location.

Monitoring points are located on-site at the waste management units, at the site security fence, around the WNYNSC perimeter and the access road, and at background locations remote from the WVDP (Figs. A-10 through A-13 [pp. A-12 through A-15]). The identification numbers associated with each location were assigned in chronological order of original installation. (See TLD Locations and Identification Numbers [p. 2-24].)

Quarterly and annual averages of TLD measurements at off-site and on-site locations are noted in Appendix H, Tables H-1 and H-2 (pp. H-3 and H-4). The results of measurements in 2002 show typical seasonal variations and are similar to results from previous years. Data from environmental TLDs for the fourth quarter of 2002 were not usable because, while being shipped for analysis, the package in which they were shipped was exposed to radiation,

either from a security x-ray machine or as a consequence of extended time in high-altitude flight.

On-Site Radiation Monitoring. Table H-2 (p. H-4) shows the average quarterly exposure rate at each on-site TLD. The on-site monitoring point with the highest dose readings was location #24. Sealed containers of radioactive components and debris from the plant decontamination work are stored nearby. This storage area is well within the WNYNSC boundary, just inside the WVDP fenced area, and is not accessible by the public.

The average exposure rate at location #24 was about 545 milliroentgens (mR) per quarter (0.25 mR/hr) during 2002, slightly higher than the exposure rate noted at this location in 2001 (0.24 mR/hr). Although 2001 and 2002 values are basically the same, exposure rates at this location have been generally decreasing over time because the radioactivity in the materials stored nearby is decaying. (See Fig. 1-1 [p. 1-10] in Chapter 1.)

The average penetrating radiation exposure rate in 2002 at locations 100 to 400 feet (30 to 120 m) distant from the integrated radwaste treatment storage building – the drum cell – including TLDs #18, #32, #34, #35, #36, and #43, was 0.02 mR/hr, about the same as in 2001 and 2000. Exposure rates around the drum cell are above background levels (by approximately 0.01 mR/hr) because the building contains drums filled with decontaminated supernatant mixed with cement. (See also Fig. 1-2 [p. 1-10] in Chapter 1.) The drum cell and the surrounding TLD locations are well within the WNYNSC boundary and are not accessible by the public.

TLD Locations and Identification Numbers

Perimeter of the WNYNSC	1–16, 20
Perimeter of the WVDP security fence	24, 26–34
On-site sources or waste management units *(Note: Some TLDs monitor more than one waste management unit.)*	18, 32–36, 43 (drum cell) 18, 19, 33, 42, 43 (SDA) 24 (component storage, near WVDP security fence) 25 (maximum measured exposure rate at the closest point of public access) 38 (main plant and, in previous years, the cement solidification system) 39 (parking lot security fence closest to the vitrification facility) 40 (high-level waste tank farm)
Near-site communities	21 (Springville) 22 (West Valley)
Background	17 (Five Points Landfill in Mansfield) 23 (Great Valley) 37 (Nashville) 41 (Sardinia)

Perimeter and Off-Site Radiation Monitoring. Table H-1 (p. H-3) lists the average quarterly exposure rate at each off-site TLD location. The perimeter TLDs (TLDs #1–16 and #20) are distributed in the sixteen compass sectors around the facility near the WNYNSC boundary. Results from the background and community TLDs were essentially the same as results from the perimeter TLDs. The perimeter TLD quarterly averages (expressed in microroentgen per hour [μR/hr]) shown on Figure 2-8 (*below*) indicate seasonal fluctuations but no long-term trends. The quarterly average of the seventeen WNYNSC-perimeter TLDs was 18.0 mR per quarter (8.2 μR/hr) in 2002, slightly lower than in 2001.

Confirmation of Results. The performance of the environmental TLDs is confirmed periodically using a portable high-pressure ion chamber (HPIC) detection system. In the third quarter of 2002 the HPIC was taken to twenty-two of the forty-three environmental TLD locations and instantaneous exposure rate readings (in μR/hr) were obtained. These readings and the comparable third-quarter environmental TLD results are listed in Table H-3 (p. H-5). The TLD results include the entire third quarter of 2002; the HPIC results were collected over a period of less than 30 minutes. (HPIC readings were not obtained at all TLD locations due to an instrument failure.)

Since the measurements are made with different systems and over differing periods of time, they are not directly comparable. Even so, the average relative percent difference between the two sets of measurements was less than 10%, indicating good agreement between these two different measurement methods. (Guidance in American National Standards Institute [ANSI] N545-1975, the standard for environmental dosimetry, uses measurement agreement within 30% total uncertainty as a performance specification for TLD measurements.)

Meteorological Monitoring

Meteorological monitoring at the WVDP provides representative and verifiable data that character-

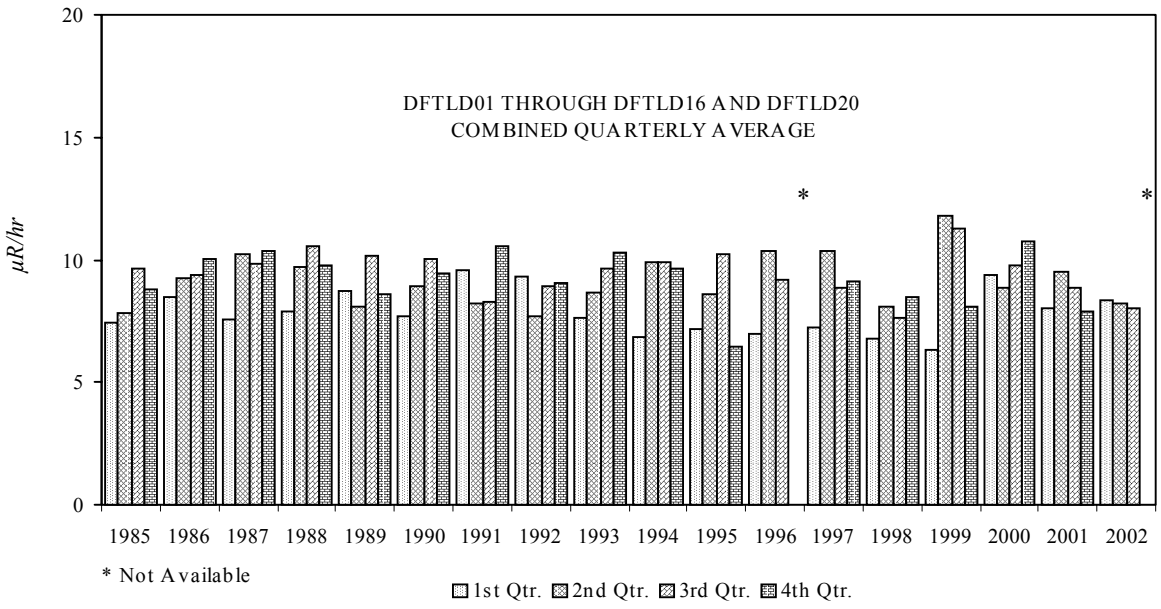


Figure 2-8. Eighteen-Year Trends of Environmental Radiation Levels at Perimeter TLDs

On-Site Meteorological Tower

ize the local and regional climatology of the site. These data are used primarily to assess potential effects of routine and nonroutine releases of airborne radioactive materials and to develop dispersion models used to calculate the effective dose equivalent to off-site residents. Since dispersive capabilities of the atmosphere are dependent upon wind speed, wind direction, and atmospheric stability (which includes a function of the difference in temperature between two elevations), these parameters are closely monitored and are available to the emergency response organization at the WVDP.

The on-site 197-foot (60-m) meteorological tower (Fig. A-1 [p. A-3]) continuously monitors wind speed, wind direction, and temperature at both the 197-foot (60-m) and 33-foot (10-m) elevations. In addition, an independent, remote 33-foot (10-m) meteorological station, located approximately 5 miles (8 km) south of the site on a hillcrest on Dutch Hill Road, continuously monitors wind speed and wind direction. (See Fig. A-12 [p. A-14].) Dewpoint, precipitation, and barometric pressure are also monitored on-site.

The two meteorological locations supply data to the primary digital and analog data acquisition systems located within the Environmental Laboratory. On-site systems are provided with either uninterruptible or standby power backup in case of site power failures. In 2002 the on-site system data recovery rate (the time valid data were logged versus the total elapsed time) was approximately 96.1%. Regional data at the 33-foot (10-m) elevation are shown on Figure I-1 (p. I-3). Figures I-2 and I-3 (pp. I-4 and I-5) illustrate the mean wind speed and wind direction at the 33- and 197-foot (10-m and 60-m) elevations on the on-site tower during 2002.

Weekly and cumulative total precipitation data are illustrated in Figures I-4 and I-5 (p. I-6) in Appendix I. Precipitation in 2002 was approximately 40 inches (102 cm), about 2.5% below the annual average of 41 inches (104 cm).

Documentation such as meteorological system calibration records, site log books, and analog strip charts are stored in protected archives. Meteorological towers and instruments are examined three times per week for proper function and are calibrated semiannually and/or whenever instrument maintenance might affect calibration.

Special Monitoring

Special monitoring comprises sampling and analyses not covered by the routine environmental monitoring program but that address items of environmental interest. Special monitoring programs are used to verify and/or track these items. No special monitoring for radiological parameters was conducted in 2002.

Radiological Effluents and Dose

Dose to the Public

Each year the potential radiological dose to the public that is attributable to operations and effluents from the WVDP is assessed to verify that no individual could credibly have received a dose exceeding the limits established by the regulatory agencies. The results of these conservative dose calculations demonstrate that the potential maximum dose to an off-site resident was well below permissible standards and was consistent with the As-Low-As-Reasonably-Achievable (ALARA) philosophy of radiation protection.

Methods used to estimate the dose to the general public resulting from exposure to radiation and radionuclides originating at the Project during calendar year 2002 are described later in this chapter. (See Dose Assessment Methodology [p. 2-29].) The resulting estimated doses are compared directly with current radiation standards established by the DOE and the EPA for protection of the public. These values are also compared with the annual dose the average resident of the United States receives from natural background radiation and to doses reported in previous years for the Project. Figure 2-9 (*below*) shows the relative contribution to the annual dose in mrem from natural and man-made sources in comparison with the estimated calendar year 2002 maximum individual dose from the WVDP. (Units of dose measurement are explained in detail on p. 2-33.)

As can be seen in Figure 2-9, natural sources of radiation contribute 295 mrem (2.95 mSv) and man-made sources contribute 65 mrem (0.65 mSv) of the total annual U.S. average dose of 360 mrem (3.60 mSv). The WVDP contributed a very small amount (0.061 mrem [0.00061 mSv]) of the total annual man-made radiation dose to the maximally

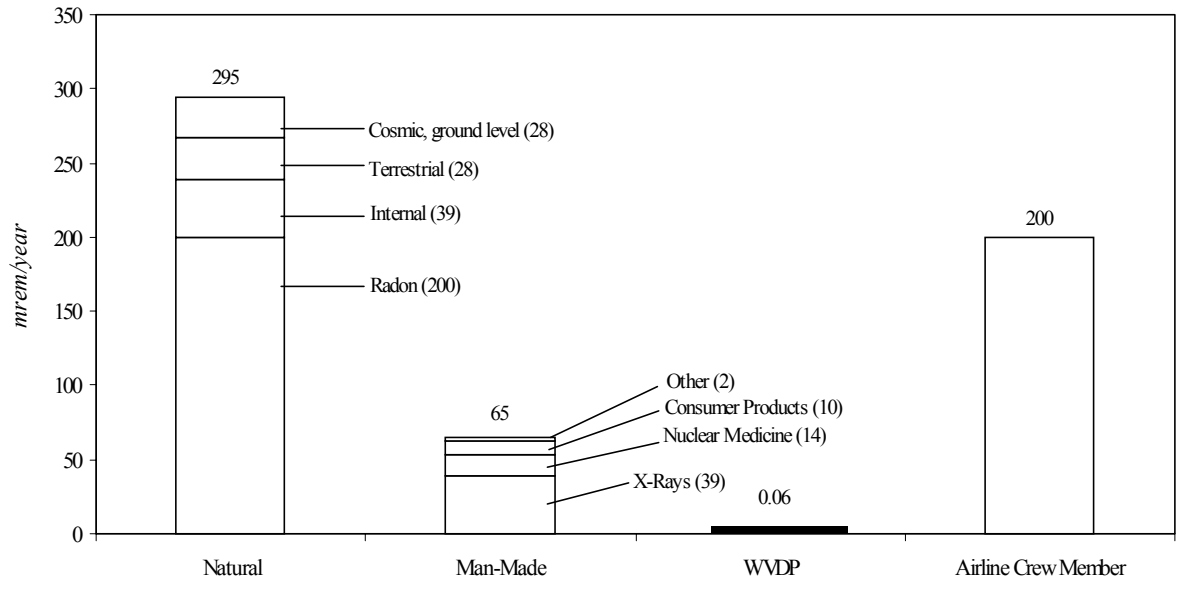


Figure 2-9. Comparison of Annual Background Radiation Dose to the Dose From 2002 WVDP Effluents

Ionizing Radiation

Radiation can be damaging if, in colliding with other matter, the alpha or beta particles or gamma rays knock electrons loose from the absorber atoms. This process is called ionization, and the radiation that produces it is referred to as ionizing radiation because it changes an electrically neutral atom, in which the positively charged protons and the negatively charged electrons balance each other, into a charged atom called an ion. An ion can be either positively or negatively charged. Various kinds of ionizing radiation produce different degrees of damage.

Potential Effects of Radiation

The biological effects of radiation can be either somatic or genetic. Somatic effects are effects to radiation exposure that are limited to the exposed individual. For example, sufficiently high exposure to radiation can cause clouding of the lens of the eye or loss of white blood cells.

Radiation also can cause chromosomes to break or rearrange themselves or to join incorrectly with other chromosomes. These changes may produce genetic effects and may show up in future generations. Radiation-produced genetic defects and mutations in the offspring of an exposed parent, while not positively identified in humans, have been observed in some animal studies.

The effect of radiation depends on the amount absorbed within a given exposure time. The only observable effect of an instantaneous whole-body dose of 50 rem (0.5 Sv) might be a temporary reduction in white blood cell count. An instantaneous dose of 100–200 rem (1–2 Sv) might cause additional temporary effects such as vomiting but usually would have no long-lasting side effects. Assessing biological damage from low-level radiation is difficult because other factors can cause the same symptoms as radiation exposure. Moreover, the body is able to repair damage caused by low-level radiation. There have been no documented effects from exposures of less than 10 rem.

The effect most often associated with exposure to relatively high levels of radiation appears to be an increased risk of cancer. However, scientists have not been able to demonstrate with certainty that exposure to low-level radiation causes an increase in injurious biological effects, nor have they been able to determine if there is a level of radiation exposure below which there are no biological effects.

Health Effects of Low-Level Radiation

Radionuclides entering the body through air, water, or food are distributed in different organs of the body. For example, isotopes of iodine concentrate in the thyroid. Strontium, plutonium, and americium isotopes concentrate in the skeleton. When inhaled, particulate uranium and plutonium isotopes remain in the lungs for a long period of time. Some radionuclides such as tritium, carbon-14, or cesium-137 are distributed uniformly throughout the body. Thus, depending on the radionuclide, some organs may receive quite different doses. Moreover, at the same dose levels, certain organs (such as the breast) are more prone to developing a fatal cancer than other organs (such as the thyroid).

Because of the uncertainty and difficulty in measuring the incidence of increased cancer resulting from exposure to ionizing radiation, to be conservative, a linear model is used to predict health risks from low levels of radiation. This model assumes that there is a risk associated with all dose levels even though the body may effectively repair damage incurred from low levels of alpha, beta, and gamma radiations.

exposed off-site individual (MEOSI) residing near the WVDP. This is much less than the average dose received from using consumer products and is insignificant compared to the federal standard of 100 mrem allowed from any DOE site operations in a calendar year or the 295 mrem received annually from natural sources. The dose from WVDP operations also is small compared to the average additional dose an airline crew member typically receives from cosmic radiation (200 mrem/year).

Dose Assessment Methodology

The potential radiation dose to the general public from activities at the WVDP is evaluated by using a two-part methodology applied in a manner consistent with the requirements in DOE Order 5400.5. The first part uses the measurements of radionuclide concentrations in liquid and air released from the Project to determine annual total effect. The second part uses measurements of radioactivity in food from locations near the Project boundaries to confirm the low impact of the totals.

Radiological dose is evaluated for all major exposure pathways, including external irradiation, inhalation, and ingestion of local food products. The dose contributions from each radionuclide and pathway combination are then summed to obtain the total dose estimates reported in Table 2-6 (p. 2-31).

Measurement of Radionuclide Concentrations in Liquid and Air Releases. Because of the difficulty of distinguishing the health effects of the small amount of radioactivity emitted from the site from that which occurs naturally in the environment using actual measurements of environmental samples, computer codes are used to model the environmental dispersion of radionuclides emitted from on-site monitored ventilation stacks and liquid discharge points.

Radiation Dose

The energy released from a radionuclide is eventually deposited in matter encountered along the path of the radiation. The radiation energy absorbed by a unit mass of material is referred to as the absorbed dose. The absorbing material can be either inanimate matter or living tissue.

Alpha particles leave a dense track of ionization as they travel through tissue and thus deliver the most dose per unit path-length. However, alpha particles are not penetrating and must be taken into the body by inhalation or ingestion to cause harm. Beta and gamma radiation can penetrate the protective dead skin layer of the body from the outside, resulting in exposure of the internal organs to radiation.

Because beta and gamma radiations deposit much less energy in tissue per unit path-length relative to alpha radiation, they produce fewer biological effects for the same absorbed dose. To allow for the different biological effects of different kinds of radiation, the absorbed dose is multiplied by a quality factor to yield a unit called the dose equivalent. A radiation dose expressed as a dose equivalent, rather than as an absorbed dose, permits the risks from different types of radiation exposure to be compared with each other (e.g., exposure to alpha radiation compared with exposure to gamma radiation). For this reason, regulatory agencies limit the dose to individuals in terms of total dose equivalent.

First, actual data from release-monitoring samples are collected, together with annual weather measurements and the most recent demographic information. (See Appendices C, D, and I.) The effective dose equivalent (EDE) to the maximally exposed off-site individual and the collective EDE to the population within a 50-mile (80-km) radius are then calculated using conservative models that

have been approved by the DOE and the EPA to demonstrate compliance with radiation standards. (See insets Radiation Dose [p. 2-29] and Units of Measurement [p. 2-33].)

Measurement of Radionuclide Concentrations in Food. The second part of the dose assessment is based on actual measurements of radioactivity in samples of foodstuffs grown in the vicinity of the WVDP and the comparison of these values with measurements of samples collected from locations well beyond the potential influence of site effluents. These measurements of environmental media show that the concentrations of radioactivity, whether from sites near the WVDP or from distant locations, are small – usually near the analytical detection limits – thereby providing additional assurance that operations at the WVDP are not adversely affecting the public.

If any of the near-site food samples contain radionuclide concentrations that are statistically higher than the concentrations in control samples, separate dose calculations are performed to verify that the calculated foodstuff dose is within the dose range estimated by computer modeling.

The maximum potential dose to nearby residents from the consumption of foods with radionuclide concentrations above background is calculated by multiplying the net concentrations (concentration in a sample minus background concentration) by the maximum adult annual consumption rate for each type of food and the unit dose conversion factor for ingestion of the measured radionuclide. The consumption rates are based on site-specific data and recommendations in NRC Regulatory Guide 1.109 for terrestrial food chain dose assessments (NRC, October 1977). The internal dose conversion factors are obtained from Internal Dose Conversion Factors for Calculation of Dose to the Public (DOE/EH-0071 [DOE, July 1988]).

Note that foodstuffs are weighed when received at the laboratory and the percent moisture is determined from the difference between the mass of the dried sample weighed after preparation for radiological measurement and the original "wet" as-measured mass. Doses are calculated based on the reconstituted "wet" mass of the original sample as it would be before preparation as food.

These calculated doses are not added to the computer-modeled estimates (Table 2-6 [p. 2-31]) because the models already include contributions from all environmental pathways.

Predicted Dose From Airborne Emissions

Airborne emissions of radionuclides are regulated by the EPA under the Clean Air Act and its implementing regulations. DOE facilities are subject to 40 CFR 61, Subpart H, NESHAP. Subpart H contains the national emission standards for emissions of radionuclides other than radon from DOE facilities. The applicable standard for radionuclides is a maximum of 10 mrem (0.1 mSv) EDE to any member of the public in any year.

Releases of airborne radioactive materials from nominal ground level stacks (1 to 24 meters high) and from the main 60-meter-high stack are modeled using the EPA-approved CAP88-PC computer code (Parks, June 1997) or equivalent. This air dispersion code estimates effective dose equivalents for the ingestion, inhalation, air immersion, and ground surface pathways.

Site-specific data for CY 2002 non-radon radionuclide releases in curies per year is listed in Tables D-1 through D-11 and D-15. (See Appendix D [pp. D-3 through D-12 and D-16].) Applicable information from these tables was used as input to the CAP88-PC code.

Table 2-6
Summary of Annual Effective Dose Equivalents to an Individual and Population From WVDP Releases in 2002

Exposure Pathways	**Annual Effective Dose Equivalent**	
	Maximally Exposed Off-Site Individual[1] mrem (mSv)	***Collective Effective Dose Equivalent[2] person-rem (person-Sv)***
Airborne Releases[3]	4.0E-03 (4.0E-05)	3.4E-02 (3.4E-04)
% EPA standard (10 mrem)	0.04%	*NA*
Waterborne Releases[4]		
Effluents only	2.6E-02 (2.6E-04)	2.3E-02 (2.3E-04)
Effluents plus north plateau drainage	5.7E-02 (5.7E-04)	2.0E-01 (2.0E-03)
Total from all Pathways	6.1E-02 (6.1E-04)	2.4E-01 (2.4E-03)
% DOE standard (100 mrem) – air and water combined	0.061%	*NA*
% of natural background (295 mrem; 453,000 person-rem) – received from air and water combined	0.02%	0.00005%
Estimated Radon-220[5]	1.3E-02 (1.3E-04)[6]	5.1E-01 (5.1E-03)

Exponents are expressed as "E" in this report: a value of 1.2 x 10^{-4} in scientific notation is reported as 1.2E-04 in the text and tables.

NA - Not applicable. Numerical regulatory standards are not set for the collective EDE to the population.

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[1] *Modeled data estimates the maximum exposure to air discharges occurs at a residence 1.9 kilometers north-northwest of the main plant.*

[2] *Population of 1.54 million within 80 kilometers of the site*

[3] *From atmospheric release non-radon point and diffuse sources. Calculated using CAP88-PC for individual and population. EPA and DOE limits for individual airborne dose are the same.*

[4] *Calculated using methodology described in Manual for Radiological Assessment of Environmental Releases at the WVDP (Spector, 2000)*

[5] *Estimated releases based on indicator measurements and vitrification processing values: dose estimates calculated using CAP88-PC*

[6] *Estimated dose from radon-220 specifically excluded by rule from NESHAP totals (see p. 2-34)*

Wind data collected from the on-site meteorological tower during 2002 and current local population distribution numbers were used as input to the CAP88-PC code.

Resulting output from the CAP88-PC code was then used to determine the total EDE from air emissions to a maximally exposed individual and the collective dose to the population within a 50-mile (80-km) radius of the WVDP.

Maximum Dose to an Off-Site Individual. Based on the non-radon airborne radioactivity released from all sources at the site during 2002, it was estimated that a person living in the vicinity of the WVDP could have received a total EDE of 0.0040 mrem (0.000040 mSv) from airborne releases. The computer model estimated that this maximally exposed off-site individual was located 1.2 miles (1.9 km) north-northwest of the site and was assumed to eat only locally produced foods. Approximately 98% of the dose from main plant stack emissions was from iodine-129. (See Iodine Emissions From the Main Stack [*this page*].)

The maximum total EDE of 0.0029 mrem (0.000029 mSv) from the permitted stacks and vents is far below levels that could be directly measured at the exposed individual's residence. This dose is comparable to about six and one-half minutes of natural background radiation received by an average member of the U.S. population and is well below the 10 mrem (0.1 mSv) NESHAP limit promulgated by the EPA and mandated by DOE Order 5400.5.

Collective Population Dose. The CAP88-PC program was used to estimate the collective EDE to the population. Based upon the latest U.S. census population data collected in CY 2000, 1.54 million people were estimated to reside within 50 miles (80 km) of the WVDP. This population received an estimated 0.034 person-rem (0.00034 person-Sv) total EDE from radioactive non-radon airborne effluents released from WVDP point and diffuse sources during 2002. The resulting average EDE per individual was 0.00002 mrem (0.0000002 mSv).

Iodine Emissions From the Main Stack. When radioactive vitrification operations began in July 1996, emission rates of radioactive isotopes of iodine increased as expected. The increase occurred because gaseous iodine was not as efficiently removed by the vitrification process off-gas treatment system as were most other radionuclides. In the ten-year period before the startup of vitrification, iodine-129, a long-lived radionuclide, was found in main stack emissions at levels of approximately 0.025 to 0.035 mCi/year. In 1996, 1.20 mCi of iodine-129 were released and in 1997, the first full year of vitrification, a maximum release of 7.4 mCi was observed. (See Fig. 2-10 [*below*].) As more HLW was vitrified, iodine-129 levels decreased and in 2002, when vitrification was completed, the total annual release had dropped to 0.45 mCi. As noted above, iodine-129 accounted for the largest proportion of dose to an off-site individual from airborne emissions from the main stack in 2002.

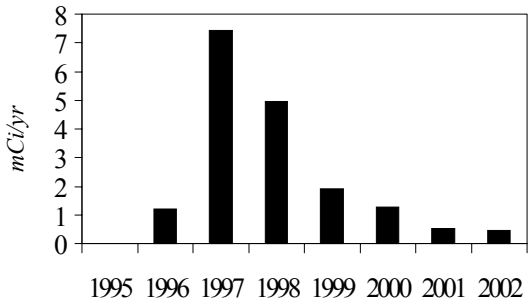


Figure 2-10. Estimated Iodine-129 Releases From the WVDP Main Plant Stack

Predicted Dose From Waterborne Releases

Currently there are no EPA standards establishing limits on the radiation dose to members of the

Units of Measurement

The unit for dose equivalent in common use in the U.S. is the rem, which stands for roentgen-equivalent-man. The international unit of dose equivalent is the sievert (Sv), which is equal to 100 rem. The millirem (mrem) and millisievert (mSv), used more frequently to report the low dose equivalents encountered in environmental exposures, are equal to one-thousandth of a rem or sievert, respectively. Other radioactivity unit conversions are found on p. UOM-2 at the back of this report.

The effective dose equivalent (EDE), also expressed in units of rem or sievert, provides a means of combining unequal organ and tissue doses into a single "effective" whole body dose that represents a comparable risk probability. The probability that a given dose will result in the induction of a fatal cancer is referred to as the risk associated with that dose. The EDE is calculated by multiplying the organ dose equivalent by the organ-weighting factors developed by the International Commission on Radiological Protection (ICRP) in Publications 26 (1977) and 30 (1979). The weighting factor is a ratio of the risk from a specific organ or tissue dose to the total risk resulting from an equal whole body dose. All organ-weighted dose equivalents are then summed to obtain the EDE.

The dose from internally deposited radionuclides calculated for a fifty-year period following intake is called the fifty-year committed effective dose equivalent (CEDE). The CEDE sums the dose to an individual over fifty years to account for the biological retention of radionuclides in the body. The total EDE for one year of exposure to radioactivity is calculated by adding the CEDE to the dose equivalent from external, penetrating radiation received during the year. Unless otherwise specified, all doses discussed here are total EDE values, which include the CEDE for internal emitters.

A collective population dose is expressed in units of person-rem or person-sievert because the individual doses are summed over the entire potentially exposed population. The average individual dose can therefore be obtained by dividing the collective dose by the number of the population.

public from liquid effluents except as applied in 40 CFR 141 and 40 CFR 143, Drinking Water Guidelines (EPA, 1984a; 1984b). Corollary limits for community water supplies are set by the New York State Department of Health (NYSDOH) in the New York State Sanitary Code (10 NYCRR 5-1.52). The private residential potable-water wells sampled for radionuclides are upgradient of the WVDP and therefore do not represent a potential source of exposure to radiation from Project activities.

Since Cattaraugus Creek is not used as a drinking water supply, a comparison of the predicted concentrations and doses with the 4-mrem/year (0.04-mSv/year) EPA and NYSDOH drinking water limits established in 40 CFR 141 and 40 CFR 143, and in 10 NYCRR §5-1.52, respectively, is not truly appropriate (although the values in creek samples are well below the EPA drinking water limits). The estimated radiation dose was compared to the applicable guidelines provided in DOE Order 5400.5. The EDE to the maximally exposed off-site individual (MEOSI) and the collective EDE

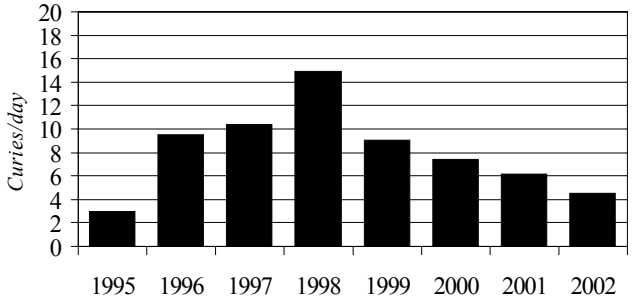
Radon-220

Radon-220 is a naturally occurring gaseous decay product of thorium-232 present in the airborne emissions from the WVDP main plant. Radon-220, also known as thoron, is associated with the thorium reduction extraction (THOREX)-related thorium-232 and uranium-232 in the high-level waste.

As reported in Chapter 2 of the 1996 WVDP Site Environmental Report (WVNSCO and Dames & Moore, June 1997), thoron levels were observed to increase during startup of the 1996 high-level waste vitrification process. An estimate of the thoron released during each waste concentration cycle was developed and used to determine a theoretical annual release. During the vitrification phase an average of about 12 curies per day were released. In 2002, because of the substantially reduced number of concentration cycles, the average was less than five curies of thoron released per day.

Although large numbers of curies were released relative to other radionuclides, the calculated dose from thoron is quite small because of its short decay half-life and other characteristics. The NESHAP rule specifically excludes thoron from air emission dose calculations at the WVDP, so a dose estimate using CAP88-PC was calculated separately. The theoretical dose to the maximally exposed off-site individual (MEOSI) located 1.2 miles (1.9 km) north-northwest of the site in 2002 would have been 0.013 mrem, and the collective dose to the population within an 80-kilometer radius would have been 0.51 person-rem. (See Table 2-6 [p. 2-31].) These theoretical doses are within the same range as doses from the man-made radionuclide WVDP effluents.

With vitrification completed, thoron releases are expected to decrease to below pre-vitrification levels. The figure presented here provides a relative indication of recent trends in the estimated annual thoron releases.



Estimated Radon-220 Releases From the WVDP

to the population due to routine waterborne releases and natural drainage are calculated using dose conversion factors as tabulated in the WVDP Manual for Radiological Assessment of Environmental Releases at the WVDP (WVNSCO, April 15, 2003).

Since the Project's liquid effluents eventually reach Cattaraugus Creek, which is not used directly as a source of drinking water, the most important individual exposure pathway is the consumption of fish from this creek by local sportsmen. It is conservatively assumed that a person may consume annually as much as 46 pounds (21 kg) of fish caught in the creek. Exposure to external radiation from shoreline or water contamination also is included in the model for estimating radiation dose. Population dose estimates assume that radionuclides are further diluted in Lake Erie before reaching municipal drinking water supplies.

The computer codes GENII version 1.485 (Pacific Northwest Laboratory, 1988), which implements the models in NRC Regulatory Guide 1.109

(NRC, 1977), and LADTAP II (Simpson and McGill, 1980) were used to calculate the site-specific unit dose factors for routine waterborne releases and dispersion of these effluents. Input data included local stream flow and dilution, drinking water usage, and stream usage factors. A detailed description of GENII is given in the WVDP Manual for Radiological Assessment of Environmental Releases at the WVDP (WVNSCO, April 15, 2003). Seven planned batch releases of liquid radioactive effluents from lagoon 3 occurred during 2002. (See Low-Level Waste Treatment Facility Effluent [p. 2-4].) Measurements of the radioactivity discharged in these effluents, listed in Appendix C, Table C-2A (p. C-13), were combined with the unit dose factors to calculate the EDE to the maximally exposed off-site individual and the collective EDE to the population living within a 50-mile (80-km) radius of the WVDP.

In addition to the batch releases from lagoon 3 (WNSP001), radioactivity measurements from the sewage treatment facility (WNSP007) effluents were included in the EDE calculations. The measured radioactivity concentrations from the sewage treatment facility are presented in Appendix C, Table C-2M (p. C-25). (The french drain at WNSP008, a third release point, has been sealed off since 2001 and was not included in this evaluation.)

Besides the two release points listed above, there are two natural drainage channels originating on the Project premises that have measurable concentrations of radioactivity in the water: the northeast swamp (WNSWAMP) and north swamp (WNSW74A). (See Northeast Swamp and North Swamp Drainage [p. 2-6].) The measured radioactivity from these points is reported in Tables C-3C and C-3D (pp. C-30 and C-31). Radioactivity measured at these drainage sample points is included in the EDE calculations for the MEOSI and the collective population.

There were no unplanned releases of waterborne radioactivity in 2002.

Maximum Dose to an Off-Site Individual. Based on the radioactivity in liquid effluents discharged from the WVDP (lagoon 3 and the sewage treatment plant) during 2002, an off-site individual could have received a maximum EDE of 0.026 mrem (0.00026 mSv). Approximately 90% of this dose was from cesium-137. This 0.026 mrem (0.00026 mSv) dose is negligible in comparison to the 295 mrem (2.95 mSv) that an average member of the U.S. population receives in one year from natural background radiation.

The maximum off-site individual EDE due to drainage from the north plateau (north swamp and northeast swamp) is 0.031 mrem (0.00031 mSv). (See Northeast Swamp Drainage Monitoring [p. 4-17].) The combined EDE to the maximally exposed individual from liquid effluents and drainage is 0.057 mrem (0.00057 mSv). This annual dose, although an increase from the 2001 estimate, is very small in comparison to the 295 mrem (2.95 mSv) dose that is received by an average member of the U.S. population from natural background radiation.

Collective Dose to the Population. As a result of radioactivity released in liquid effluents from the WVDP (lagoon 3 and the sewage treatment plant) during 2002, the population living within 50 miles (80 km) of the site received a collective EDE of 0.023 person-rem (0.00023 person-Sv). The collective dose to the population from the north plateau drainage is 0.18 person-rem (0.0018 person-Sv). This estimate is based on a population of 1.54 million living within the 50-mile (80-km) radius. The resulting average EDE from lagoon 3, the sewage treatment plant, and north plateau drainage (north swamp and northeast swamp) per individual is 1.3E-04 mrem (1.3E-06 mSv). This dose of 0.00013 mrem (0.0000013 mSv) is an inconsequential addition to the dose

that an average person receives in one year from natural background radiation.

Calculated Dose From Local Foodstuff Tests

Fish. Samples of fish were collected from Cattaraugus Creek from May 2002 through November 2002. (See Fish [p.2-21].) The calculated maximum dose to an individual from consuming 46 pounds (21 kg) of near-site fish would be approximately 0.02 mrem (0.0002 mSv) in a year. This dose is roughly equivalent to the dose received every 35 minutes from background radiation.

Venison. Meat samples from near-site and control deer were collected during the fall of 2002. (See Venison [p. 2-22].) Individual concentrations of measured radionuclides in near-site venison samples were not statistically different from concentrations at control locations.

Beef. Individual concentrations of measured radionuclides in near-site beef samples were not statistically different from concentrations at control locations. (See Beef [p. 2-23].)

Milk. Results from near-site milk samples were collected and compared with background samples. (See Milk [p. 2-23].) Average values for tritium, strontium-90, iodine-129, and cesium-137 were not statistically different from control concentrations. Naturally-occurring potassium-40, used as an intrinsic reference point for the samples, was at the expected level.

Produce (Corn, Beans, and Apples). Except for strontium-90, individual concentrations of all measured radionuclides in near-site produce samples were not statistically different from concentrations at control locations. Strontium-90 concentrations in near-site vegetables were slightly elevated with respect to background. (See Vegetables, Fruit, and Forage [p. 2-23].) Strontium-90 in apples collected near the WVDP in 2002 was about twice the level reported in apples at the remote background location. Strontium-90 was elevated at about three and four times the 2002 background levels in near-site beans and corn, respectively. Were these combined near-site foods to have been consumed in 2002 in normal quantities by the same person, that individual would have received about 0.10 mrem (0.0010 mSv), the equivalent of about three hours of natural background radiation. In perspective, the strontium-90 reported in remote background produce analyzed in 2001 was up to eight times higher than strontium-90 in the 2002 background produce, indicating a wide variability in vegetation measurements. There were no measured releases of radioactivity from the WVDP in 2002 that would account for a corresponding increase of radioactivity in produce.

Predicted Dose From All Pathways

The potential dose to the public from both airborne and liquid effluents released from the Project during 2002 is the sum of the individual dose contributions. The calculated maximum EDE from all pathways to a nearby resident was 0.061 mrem (0.00061 mSv). This dose is 0.06% of the 100-mrem (1-mSv) annual limit in DOE Order 5400.5. The estimated dose from radon-220 to the same nearby resident was less than 0.02 mrem.

The total collective EDE to the population within 50 miles (80 km) of the site was 0.24 person-rem (0.0024 person-Sv), with an average EDE of 0.00015 mrem (0.0000015 mSv) per individual. The estimated radon-220 dose to the population , calculated additionally, was approximately 0.5 person-rem.

Table 2-6 (p. 2-31) summarizes the dose contributions from all pathways and compares the individual doses with the applicable standards. The

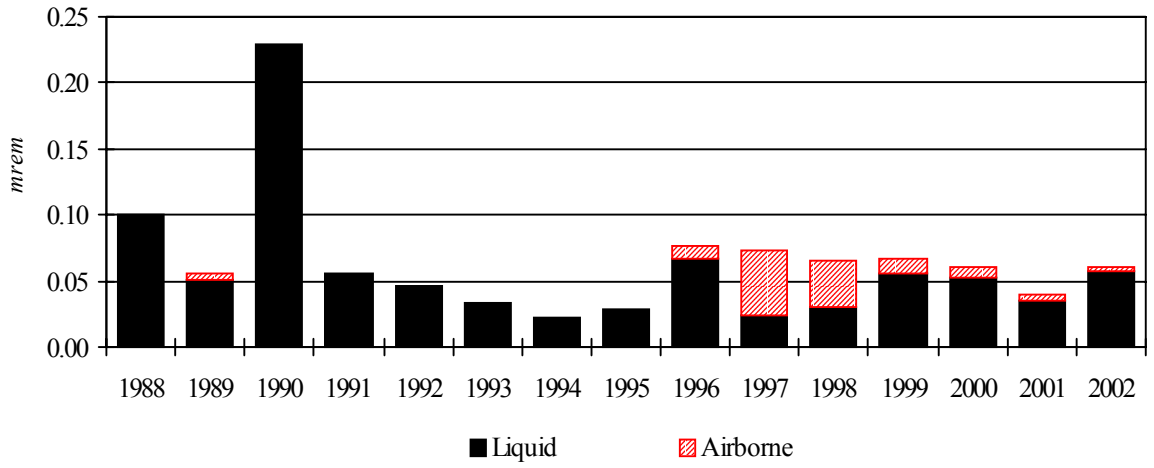


Figure 2-11. Effective Dose Equivalent From Liquid and Airborne Effluents to a Maximally Exposed Individual Residing Near the WVDP

low doses calculated using computer modeling are corroborated by the low or non-detectable doses calculated from local foodstuff test data.

Figure 2-11 (*above*) shows the calculated annual dose to the hypothetical maximally exposed individual over the last fifteen years. The estimated dose for 2002 (0.06 mrem) is higher than the annual dose reported for 2001 (0.04 mrem). The decrease in dose fraction from air emissions in 2002 is attributed to the continuing decrease in iodine-129 emissions. The higher dose from the liquid pathway is mostly the result of a higher volume of releases from the water treatment system. This increase includes the continuing effect of the gross beta plume. (See Special Groundwater Monitoring in Chapter 4 [p. 4-16].)

Figure 2-12 (p. 2-38) shows the collective dose to the population over the last fifteen years. (See Fig. A-14 [p. A-16] for a map of the population sectors.) A five-year upward trend, primarily from an increase in vitrification activities, reversed in 1998 and is trending toward previtrification levels.

As with the individual dose, a slight upward trend in collective dose from treated liquid effluents, directly linked to a noticeable increase in the volume of water treated, was noted in 2002.

The overall radioactivity represented by these data confirms the continued inconsequential addition to the natural background radiation dose that the individuals and population around the WVDP receive from Project activities.

Risk Assessment

Estimates of cancer risk from ionizing radiation have been presented by the NCRP (1987b) and the National Research Council's Committee on Biological Effects of Ionizing Radiation (BEIR, 1990).

These reports estimate that the probability of fatal cancer induction to the public, averaged over all ages, ranges from 0.0001 to 0.0005 cancer fatalities per rem. DOE guidance has, in the past, recommended using a risk coefficient of 0.0005 (ICRP, 1991) to estimate risk to a maximally exposed off-site individual. Recent DOE guidance recommends using an even more conservative risk coefficient of 0.0006

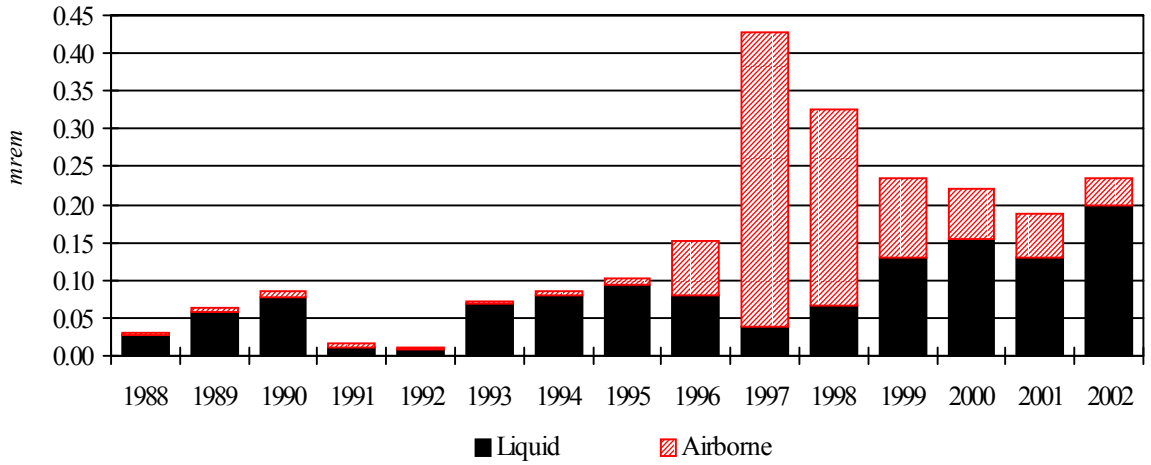


Figure 2-12. Collective Effective Dose Equivalent From Liquid and Airborne Effluents to the Population Residing Within 50 Miles (80 km) of the WVDP

provided by the Interagency Steering Committee on Radiation Standards (ISCORS, January 2003). The resulting estimated risk to this hypothetical individual residing near the WVDP from airborne and waterborne releases in 2002 was a 0.000000037 probability of a cancer fatality (1 chance in 27 million). This risk is well below the range of 0.000001 to 0.00001 per year considered by the ICRP in Report Number 26 (1977) to be a reasonable risk for any individual member of the public.

Dose to Biota: Aquatic and Terrestrial Wildlife

Radionuclides from both natural and man-made sources may be found in environmental media such as water, sediments, and soils. In the past, it has been assumed that if radiological controls are sufficient to protect humans, other living things are also likely to be sufficiently protected. This assumption is no longer considered adequate, since populations of plants and animals residing in or near these media or taking food or water from these media may be exposed to a greater extent than are humans. For this reason, the DOE prepared a technical standard which provides methods and guidance to be used to evaluate doses of ionizing radiation to populations of aquatic animals, terrestrial plants, and terrestrial animals.

Methods in this technical standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-STD-1153-2002, July 2002), were used in 2002 to evaluate radiation doses to aquatic and terrestrial biota within the confines of the WNYNSC, which includes the WVDP. Doses were assessed for compliance with the limit in DOE Order 5400.5 for native aquatic animal organisms (1 rad per day) and for compliance with the thresholds for terrestrial plants (also 1 rad per day) and for terrestrial animals (0.1 rad per day), as proposed in DOE-STD-1153-2002. Note that the absorbed dose unit (rad) is used for biota instead of the units used for indicating human risk (rem).

RAD-BCG, a calculation tool provided by the DOE for implementing the technical standard, was used to compare existing radionuclide concentration data from environmental sampling with biota concentration guide (BCG) screening values. Data collected from surface waters, sediments, and soils on and around the WNYNSC over a ten-year

period (1991–2000) were used as a baseline. For a more near-term assessment, a second evaluation was completed using surface water data from 2002 and sediment data from 1998–2002. (See Appendices A and B for maps and descriptions of monitoring and surveillance locations. Radionuclides analyzed for each medium at each location are listed in Appendix B. See Appendices C and G for a listing of results from these locations in 2002.)

Concentration data for radionuclides in each medium were entered into the calculation tool. The value for each radionuclide was automatically divided by the BCG in order to calculate a partial fraction for each nuclide for each medium. Partial fractions for each medium were added to produce a sum of fractions.

It was found that the isotopes with the highest sums of fractions – the radionuclides that contributed the largest component of both aquatic and terrestrial dose to biota – were strontium-90 and cesium-137. Per guidance in DOE-STD-1153-2002, the populations of organisms most sensitive to strontium-90 and cesium-137 in this evaluation – that is, those populations residing on the WNYNSC that were most likely to be adversely affected via the aquatic and terrestrial pathways – were determined to be populations of the raccoon (aquatic dose) and the deer mouse (terrestrial dose). As such, this study does not pertain to pathways to humans, which are addressed elsewhere. (See Dose Assessment Methodology [p. 2-29].)

The aquatic dose limit from DOE Order 5400.5 may be assumed to have been met if the sum of fractions for the water medium plus that for the sediment medium is less than 1.0. Similarly, proposed dose limits for both terrestrial plants and animals may be assumed to have been met if the sum of fractions for the water medium plus that for the soil medium is less than 1.0.

In accordance with the approach described in DOE-STD-1153-2002, a general screening was first conducted using the maximum radionuclide concentrations from surface waters, sediments, and soils. Maximum radionuclide concentrations from the ten-year sampling database exceeded applicable general screening BCG limits for both aquatic and terrestrial evaluations, as did the maximum concentrations from the 2002 surface water data and the more recent sediment data.

As recommended in DOE-STD-1153-2002, a site-specific screening was then done using estimates of average radionuclide concentrations derived from measurement series in surface waters, sediments, and soils. Average concentrations for each medium, applicable BCGs, partial fractions, and sums of fractions for the ten-year baseline study are tabulated in Table 2-7 (p. 2-41).

At the site-specific screening level for the full ten-year period, the sums of fractions for the aquatic and terrestrial system evaluations were 0.45 and 0.57, respectively. The comparable sums of fraction using the more near-term data were 0.31 and 0.57, respectively. The sum of fractions for each assessment was less than 1.0, indicating that applicable BCGs were met for both the aquatic and terrestrial evaluations. It was therefore concluded that populations of aquatic and terrestrial biota (both plants and animals) on the WNYNSC are not being exposed to doses in excess of the existing DOE dose standard for aquatic animals and the recommended standards for terrestrial biota.

Summary

Predictive computer modeling of airborne and waterborne releases resulted in estimated hypothetical doses to the maximally exposed individual that were orders of magnitude below all applicable EPA standards and DOE Orders, which place limitations on the release of radioactive materials and

dose to individual members of the public. The collective population dose also was assessed and found to be orders of magnitude below the natural background radiation dose. Additionally, it was determined that biota at the WVDP are exposed at a fraction of the suggested maximum radiation levels.

Based on the overall dose assessment, the WVDP was found to be in compliance with applicable effluent radiological guidelines and standards during calendar year 2002. Table 2-8 (p. 2-42) provides a summary of WVDP releases and calculated doses in specified DOE format.

Table 2-7
Evaluation of Dose to Aquatic and Terrestrial Biota

Based on average radionuclide concentrations in waters, sediments, and soils from ten years of monitoring, the sum of fractions for the aquatic system evaluation was 0.45 and that for the terrestrial system evaluation was 0.57. Evaluations using more recent data – surface water data from 2002 and sediment data from 1998–2002 – resulted in aquatic and terrestrial sums of fractions of 0.31 and 0.57, respectively. Each sum of fractions was less than 1.0, indicating that applicable biota concentration guides (BCGs) were met for both the aquatic and terrestrial evaluations. The calculated sum of fractions for the aquatic system for the near-term assessment was less than the sum of fractions calculated for the 10-year baseline. It was therefore concluded, based on both long-term and near-term results, that populations of aquatic and terrestrial biota on the WNYNSC are not being exposed to doses in excess of the existing DOE limit for native aquatic animal organisms (U.S. Department of Energy, February 1990) and the international standards for terrestrial organisms (International Atomic Energy Agency, 1992).

Aquatic System Evaluation (Near-Term Data Set)

Nuclide	Water BCG* (pCi/L)	Mean Water Value (pCi/L)	Water Partial Fraction	Sediment BCG* (pCi/g)	Mean Sediment Value (pCi/g)	Sediment Partial Fraction	Water and Sediment Sum of Fractions
Cesium-137	42.6	7.42	1.74E-01	3,120	10.1	3.23E-03	0.18
Strontium-90	278	36.1	1.30E-01	582	0.899	1.54E-03	0.13
All Others	NA	NA	1.97E-03	NA	NA	5.03E-04	<0.01
Sum of Fractions (Near-Term Data)			3.06E-01			5.28E-03	**0.31**
Sum of Fractions (Long-Term [10-Yr] Data)			4.47E-01			5.65E-03	**0.45**

Terrestrial System Evaluation (Near-Term Data Set)

Nuclide	Water BCG* (pCi/L)	Mean Water Value (pCi/L)	Water Partial Fraction	Soil BCG* (pCi/g)	Mean Soil Value (pCi/g)	Soil Partial Fraction	Water and Soil Sum of Fractions
Cesium-137	599,000	7.42	1.24E-05	20.8	5.95	2.87E-01	0.29
Strontium-90	54,500	36.1	6.63E-04	22.5	6.26	2.78E-01	0.28
All Others	NA	NA	2.06E-06	NA	NA	1.00E-03	<0.01
Sum of Fractions (Near-Term Data)			6.77E-04			5.66E-01	**0.57**
Sum of Fractions (Long-Term [10-Yr] Data)			7.20E-04			5.66E-01	**0.57**

* The BCGs are calculated values. Except for the sums of fractions, which are rounded to two significant digits, all values are expressed to three significant digits.

Table 2-8
WVDP Radiological Dose and Release Summary

WVDP Radiological Dose Reporting Table CY 2002

Dose to the Maximally Exposed Individual		% of DOE 100-mrem Limit	Estimated Population Dose		Population Within 50 Miles *(2000 census)*	Estimated Natural Radiation Population Dose
0.060 *mrem*	0.00060 *(mSv)*	0.060	0.24 *person-rem*	0.0024 *(person-Sv)*	1,536,000	453,000 *person-rem*

WVDP Radiological Atmospheric Emissions+ CY 2002 in Curies (Bq)

Tritium	Kr-85	Noble Gases ($T_{½}$<40 dy)	Short-Lived Fission and Activation Products ($T_{½}$<3 hr)	Fission and Activation Products ($T_{½}$>3 hr)	Total Radioiodine	Total Radiostrontium	Total Uranium*	Total Plutonium	Total Other Actinides	Other (Rn-220)
7.10E-02 (2.63E+09)	NA	NA	NA	1.46E-05 (5.38E+05)	4.64E-04 (1.72E+07)	7.58E-06 (2.81E+05)	2.89E-07 (1.07E+04)	6.92E-07 (2.56E+04)	1.12E-06 (4.14E+04)	1.65E+03 (6.10E+13)

WVDP Liquid Effluent Releases+ of Radionuclide Material CY 2002 in Curies (Bq)

Tritium	Fission and Activation Products ($T_{½}$>3 hr)	Total Radioiodine	Total Radiostrontium	Total Uranium**	Total Plutonium	Total Other Actinides
1.46E-01 (5.40E+09)	8.30E-03 (3.07E+08)	1.88E-04 (6.95E+06)	2.06E-01 (7.62E+09)	1.03E-03 (3.79E+07)	1.55E-05 (5.47E+05)	2.29E-05 (8.49E+05)

+ The WVDP air and water releases are from point source and controlled liquid effluent releases, respectively.

* Total uranium (grams) = 2.43E-01

** Total uranium (grams) = 9.13E+01

Note: These tables have been included to provide a standardized format for data collected from all Department of Energy sites.